MERCURY
MerCruiser

SERVICE MANUAL

Number 30

496CID/8.1L GASOLINE ENGINE

INDEX

MAIN MENU

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Notice

Throughout this publication, “Dangers”, “Warnings” and “Cautions” (accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. **OBSERVE THEM CAREFULLY!**

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus “Common Sense” operation, are major accident prevention measures.

⚠ DANGER

DANGER - Immediate hazards which WILL result in severe personal injury or death.

⚠ WARNING

WARNING - Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠ CAUTION

Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers’ mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine, that they have been trained in the recommended servicing procedures of these products which includes the use of mechanics’ common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note, during any maintenance procedure replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

We reserve the right to make changes to this manual without prior notification.

Refer to dealer service bulletins for other pertinent information concerning the products described in this manual.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts, will void the warranty on those parts which are damaged as a result of the use of other than recommended replacement parts.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Models Covered in This Manual

Sterndrive (MCM) Model	Serial Number
496 Mag HO	0M000000 & Up
496 Mag	0M000000 & Up

Inboard (MIE) Model	Serial Number
8.1S HO	0M000000 & Up
8.1S Horizon	0M000000 & Up

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Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How to Use This Manual

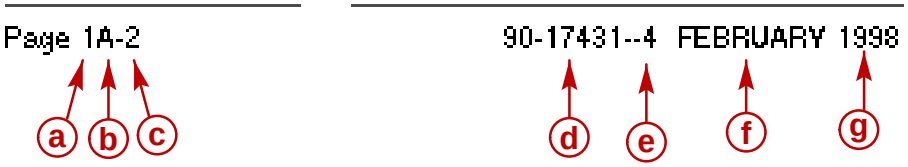
This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Sections and section parts are listed on the Service Manual Outline page following V-8 Models Covered in This Manual page.

Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.



a - Section Number
b - Section Part
c - Page Number
d - Manual Number
e - Revision No. 4
f - Month Printed
g - Year Printed

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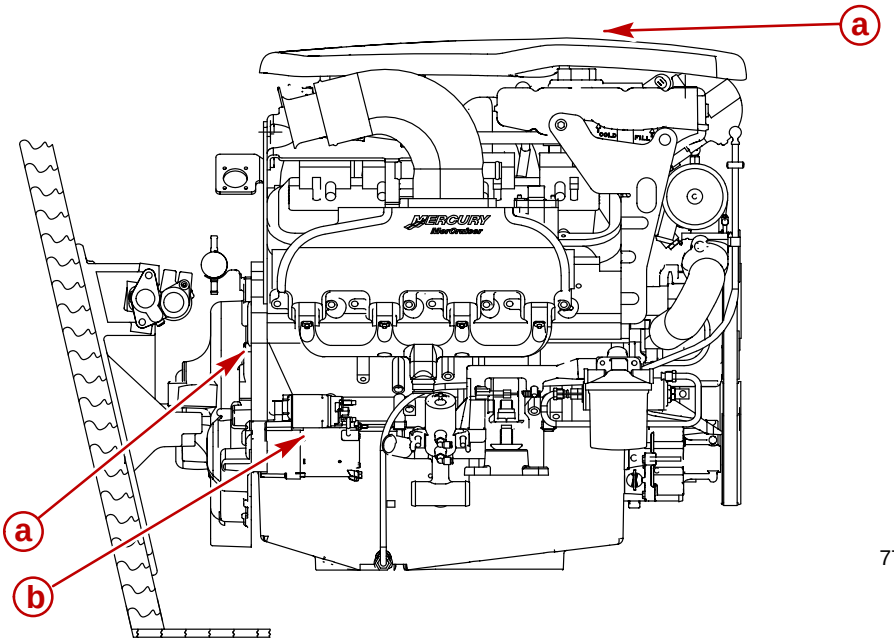
Engine Serial Number Locations



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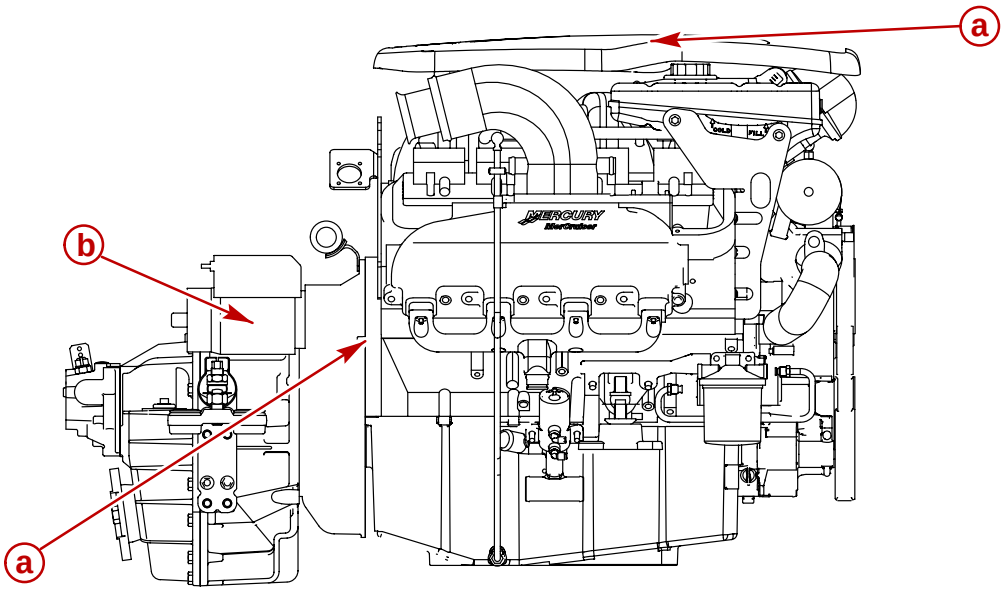
Sterndrive (MCM)

a - Serial Number Plate
b - Starter Motor



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Inboard (MIE)

a - Serial Number Plate
b - Starter Motor

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Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite Pipe Sealant With Teflon	Obtain Locally
Quicksilver U-Joint and Gimbal Bearing Grease	92-828052A2
Quicksilver Engine Coupler Spline Grease	92-816391A4

Maintenance Schedules

Maintenance Intervals

Maintenance intervals and the corresponding tasks, as shown in this schedule or found in a previous schedule, are based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can impact the suggested intervals. In consideration of these factors, Mercury Mercruiser has adjusted some maintenance intervals and corresponding tasks. In some cases, this may allow for more individual tasks to be performed in a single visit to the serving dealer. Therefore, the boat owner and servicing dealer should discuss the current Maintenance Schedule and develop appropriate maintenance intervals.

Always disconnect battery cables from battery BEFORE working around electrical systems components to prevent injury to yourself and damage to electrical system should a wire be accidentally shorted.

Gas Inboard

Routine Maintenance *	Each Day Start	Each Day End	Weekly	Every Two Months
Check crankcase oil (interval can be extended based on experience).	★			
If operating in salt, brackish or polluted waters, flush cooling system after each use.		★		
Check transmission fluid.			★	
Check water pickups for debris or marine growth. Check water strainer and clean. Check coolant level.			★	

* Only perform maintenance which applies to your particular power package

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Gas Inboard (Continued)

Scheduled Maintenance *

	Annually	Every 100 hours or Annually ◆	Every 200 hours or 3 years ◆	Every 300 hours or 3 years ◆	Every 2 years	Every 5 years	Every 500 hours or 5 years ◆	Every 1000 hours or 5 years ◆	Per OEM
Touch-up paint power package and spray with corrosion guard.	★								
Change crankcase oil and filter.		★							
Change transmission fluid.		★							
Replace fuel filter(s).		★							
Check steering system and remote control for loose, missing or damaged parts. Lubricate cables and linkages.		★							
Retorque engine mounts.				★					
Check spark plugs and wires.				★					
Clean flame arrestor.				★					
Check electrical system for loose, damaged or corroded fasteners.				★					
Inspect condition and tension of belts.				★					
Check cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.				★					
Disassemble and inspect seawater pump and replace worn components.				★					
Clean seawater section of closed cooling system. Clean, inspect and test pressure cap.				★					
Replace coolant.						★			
Check engine-to-propeller shaft alignment.									★

* Only perform maintenance which applies to your particular power package

◆ Whichever Occurs First

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Gas Sterndrive

Routine Maintenance *	Each Day Start	Each Day End	Weekly	Every Two Months
Check crankcase oil (interval can be extended based on experience).	★			
If operating in salt, brackish or polluted waters, flush cooling system after each use.		★		
Check drive unit oil level, trim pump oil level and power steering pump fluid level.			★	
Check water pickups for debris or marine growth. Check water strainer and clean. Check coolant level.			★	
Inspect drive unit anodes and replace if 50 percent eroded.			★	
Check battery connections and fluid level.				★
Lubricate propeller shaft and the retorque nut (if operating in only freshwater, this maintenance may be extended to every four months).				★
Operating in Saltwater Only: treat engine surface with corrosion guard.				★

* Only perform maintenance which applies to your particular power package

Gas Sterndrive (Continued)

Scheduled Maintenance *

	Annually	Every 100 Hours or Annually◆	Every 200 Hours or 3 Years◆	Every 300 Hours or 3 Years◆	Every 2 Years	Every 5 Years
Touch-up paint power package and spray with corrosion guard.	★					
Change crankcase oil and filter.		★				
Change drive unit oil and retorque connection of gimbal ring to steering shaft.		★				
Replace fuel filter.		★				
Check steering system and remote control for loose, missing or damaged parts. Lubricate cables and linkages.		★				
Inspect and lubricate U-joints and splines; inspect bellows and clamps. Check engine alignment.			★			
Lubricate gimbal bearing and engine coupler.			★8			
Check continuity circuit for loose or damaged connections. Test MerCathode® unit output on Bravo models.			★			
Retorque engine mounts.				★		
Check spark plug and wires.				★		

* Only perform maintenance which applies to your particular power package

◆ Whichever Occurs First

8 Lubricate engine coupler every 50 hours if operated at idle for prolonged periods of time.

Gas Sterndrive (Continued)

Scheduled Maintenance * (Continued)	Annually	Every 100 Hours or Annually◆	Every 200 Hours or 3 Years◆	Every 300 Hours or 3 Years◆	Every 2 Years	Every 5 Years
Clean flame arrestor.				★		
Check electrical system for loose, damaged or corroded fasteners.				★		
Inspect condition and tension of belts.				★		
Check cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.				★		
Disassemble and inspect seawater pump and replace worn components.				★		
Clean seawater section of closed cooling system. Clean and inspect pressure cap.				★		
Replace coolant.					♠	★

* Only perform maintenance which applies to your particular power package

◆ Whichever occurs first.

♠ Interval will be reduced if not using extended life coolant.

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Specifications

MCM (Sterndrive) Models

Model	496 MAG	496 MAG HO
Propshaft Horsepower	375[1]	425[1]
Propshaft Kilowatts	280	317
Number of Cylinders	8	
Displacement	496 cid (8.1 l)	
Bore/Stroke in. (mm)	4.25 / 4.38 (108 / 111)	
Compression Ratio	9.1:1	
Compression Pressure	Minimum 100 psi (690 kPa)[3]	
Idle rpm (in Neutral Gear)	650[2]	
Max. rpm (at WOT)	4400-4800[2]	4600-5000[2]
Oil Pressure (at 2000 rpm)	60 psi (414 kPa)	
Oil Pressure (at Idle)	30 psi (207 kPa)	
Electrical System	12 V Negative (–) Ground	
Fuel Pressure (Running)	6 psi (41 kPa)	
Alternator Rating - Hot Operating Amps	65 Amps	
Alternator Rating - Cold Operating Amps	72 Amps	
Min. Battery Requirements	650 cca / 825 mca / 150Ah	
Firing Order	1-8 7-2 6 5 4 3	
Spark Plug Type	Denso TJ14R-P15	
Spark Plug Gap	0.060 in.(1.52 mm)	
Thermostat	160° F (71° C)	

[1] Power rated in accordance with NMMA (National Marine Manufacturer's Association) rating procedures.

[2] Measured using a accurate service tachometer with engine at normal operating temperature.

[3] Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

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MIE (Inboard) Models

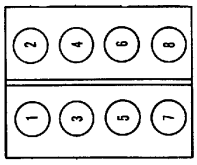
Model	8.1S Horizon	8.1S HO
Propshaft Horsepower	370[1]	420[1]
Propshaft Kilowatts	276	313
Number of Cylinders	8	
Displacement	496 cid (8.1 l)	
Bore/Stroke in. (mm)	4.25 / 4.38 (108 / 111)	
Compression Ratio	9.1:1	
Compression Pressure	Minimum 100 psi (690 kPa)[3]	
Idle rpm (in Neutral Gear)	650[2]	
Max. rpm (at WOT)	4200-4600[2]	4400-4800[2]
Oil Pressure (at 2000 rpm)	60 psi (414 kPa)	
Oil Pressure (at Idle)	30 psi (207 kPa)	
Electrical System	12 V Negative (–) Ground	
Fuel Pressure (Running)	6 psi (41 kPa)	
Alternator Rating - Hot Operating Amps	65 Amps	
Alternator Rating - Cold Operating Amps	72 Amps	
Min. Battery Requirements	650 cca / 825 mca / 150Ah	
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Type	Denso TJ14R-P15	
Spark Plug Gap	0.060 in. (1.52 mm)	
Thermostat	160° F (71° C)	

[1] Power rated in accordance with NMMA (National Marine Manufacturer's Association) rating procedures.

[2] Measured using a accurate service tachometer with engine at normal operating temperature.

[3] Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

Firing Order



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LH ROTATION FRONT FIRING ORDER 1-8-7-2-6-5-4-3

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Fluid Capacities

Engines

NOTICE
Unit Of Measurement: U.S. Quarts (Liters)
All capacities are approximate fluid measures.

Model	MCM and MIE 496 cid / 8.1L
Crankcase Oil [1] (With Filter)	9 (8.5)
Seawater Cooling System [2]	20 (19)
Closed Cooling System	19 (18)

[1] Use dipstick to determine exact level.

[2] Seawater cooling system capacity information is for winterization use only.

IMPORTANT: It may be necessary to adjust oil levels depending on installation angle and cooling systems (heat exchanger and fluid lines).

Transmissions

NOTICE
Unit Of Measurement: U.S. Quarts (Liters)
All capacities are approximate fluid measures.

Make and Model		Capacity Quarts (Liters) [1]	Fluid Type
Velvet Drive	5000A 5000V	2-3/4 (2.6) 3-1/2 (3.3)	Dexron III Automatic Transmission Fluid
ZF (Hurth)	630A 630V 800A	3-1/4 (3.0) 4-1/4 (4.0) 5-3/4 (5.5)	

[1] Always use dipstick to determine exact quantity of fluid required.

Sterndrive Units

NOTICE
Unit Of Measurement: U.S. Fluid Ounces (Milliliters)
All capacities are approximate fluid measures.

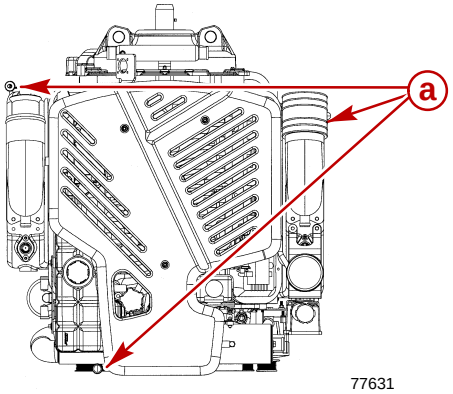
Model	Bravo One	Bravo Two	Bravo Three
Drive Unit Oil Capacity (With Gear Lube Monitor)	88 (2603)	104 (3076)	96 (2839)

Checking Engine Oil Level/Filling

⚠ CAUTION

ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as defined by local authorities.

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan.
3. Remove dipstick. Wipe clean and reinstall. Push dipstick all the way into dipstick tube.



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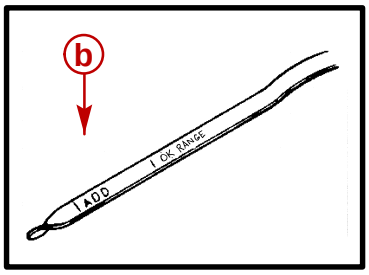
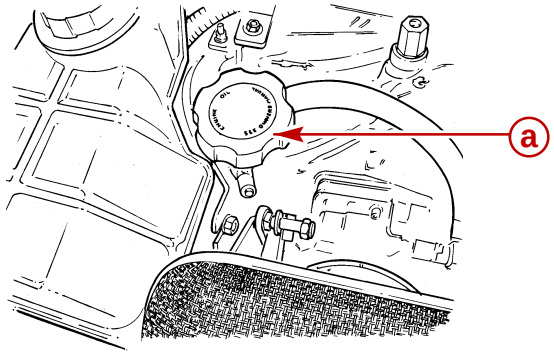


77628

a - Oil Dipstick Tubes
b - Add Mark

4. Remove dipstick and note the oil level.
5. Oil level must be between the FULL or OK RANGE and ADD marks.
6. If oil level is below ADD mark, remove oil filler cap and add required amount.



77519

a - Oil Cap

Changing Crankcase Oil and Filter

IMPORTANT: Change crankcase oil when engine is warm from operation. Warm oil flows more freely, carrying away more impurities. Use only recommended engine oil (refer to Specifications).

1. Start engine and run until it reaches normal operating temperature.
2. Stop engine.
3. If equipped with quick drain oil, remove drain plug from boat hull.
   a. Pull plug and tether until quick drain oil hose comes through the hull.
   b. Remove plug with attached tether from quick drain oil hose.
   c. Drain oil completely.
   d. Reinstall plug into quick drain oil hose.
   e. Push hose and tether through drain plug in rear of boat and reinstall drain plug.

NOTE: *If engine is factory equipped with Quick Drain Oil Hose, pull tether through bilge drain before removing drain plug from oil drain hose.*

NOTE: *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)*

4. If not equipped with quick drain oil, drain crankcase oil using Quicksilver Crankcase Oil Pump.
   a. Insert hose end of crankcase oil pump onto an appropriate container and using handle, pump until crankcase is empty.
   b. Remove pump.
   c. After oil has drained completely, reinstall drain plug or dipstick and tighten securely.
5. Remove and discard oil filter.
6. Coat sealing ring on new filter with engine oil and install. Tighten filter securely (following filter manufacturer's instructions). DO NOT overtighten.
7. Remove oil filler cap. Add recommended engine oil to bring level up to, but not over, OK RANGE mark on dipstick. Refer to Specifications.
8. Start engine and check for leaks.

IMPORTANT: Always use dipstick to determine exactly how much oil is required.

Changing Water Separating Fuel Filter

⚠ WARNING

Be careful when changing water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Be sure ignition key is OFF. Do not smoke or allow spark or open flame in area when changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠ CAUTION

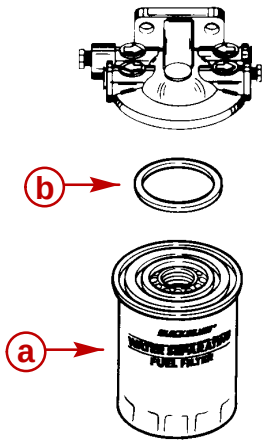
The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

The installation of additional filters may cause:

- Fuel Vapor Locking
- Difficult Warm-Starting
- Piston Detonation Due to Lean Fuel Mixture
- Poor Driveability

Removal

1. Remove water separating fuel filter and sealing ring from mounting bracket. Discard filter and sealing ring.



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a - Fuel Filter
b - Sealing Ring

Installation

1. Coat sealing ring on new water separating fuel filter with new engine oil. Thread water separating fuel filter onto bracket and tighten securely by hand. DO NOT use a filter wrench.
2. Start and operate engine. Check water separating fuel filter connection for gasoline leaks. If leaks exist, stop engine immediately and recheck filter installation.

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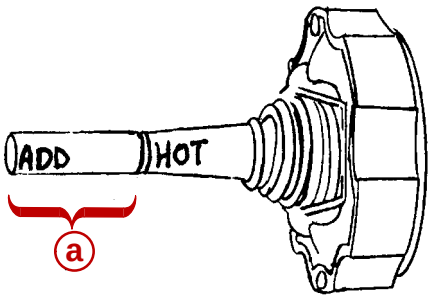
Power Steering System

Checking Fluid Level

ENGINE WARM

1. Stop engine and center sterndrive unit.
2. Remove dipstick from power steering reservoir and note fluid level.
3. Level should be between the FULL HOT mark and ADD mark on dipstick.



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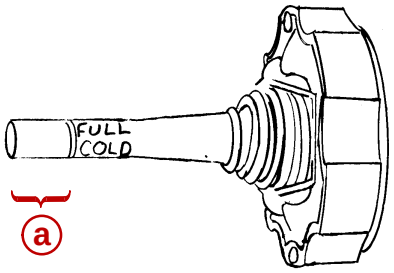
a - Proper Fluid Level With Engine Warm

4. If level is below ADD mark, but fluid is visible in reservoir, add required amount of fluid to bring level up to FULL HOT mark on dipstick. DO NOT overfill.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

ENGINE COLD

1. Center sterndrive unit.
2. Remove dipstick from power steering reservoir and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.



77569

a - Proper Fluid Level with Engine Cold

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of fluid to bring level up to FULL COLD mark on dipstick. DO NOT overfill.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Filling and Bleeding

IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid may also cause power steering system to become spongy, which may result in poor boat control.

1. Stop engine and center sterndrive unit. Remove fill cap from power steering reservoir. Add fluid to bring level up to FULL HOT mark on dipstick. DO NOT overfill.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or Dexron III automatic transmission fluid (ATF) in power steering system.

2. Slowly turn steering wheel back and forth to end of travel in each direction several times, then recheck fluid level. Add fluid, if necessary.
3. Install fill cap.

⚠ CAUTION

Supply water to seawater pickup pump before operating engine to prevent pump impeller damage and subsequent overheating of engine.

4. Start engine and operate at idle (650 rpm) until engine reaches normal operating temperature. During this time, slowly turn steering wheel back and forth to end of travel in each direction several times.

IMPORTANT: When reinstalling pressure cap, tighten securely.

IMPORTANT: Sterndrive unit must be centered and power steering fluid must be hot to accurately check fluid level.

5. Stop engine and center sterndrive unit. Remove fill cap from reservoir. Allow any foam in pump reservoir to disperse, then check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT overfill. Reinstall fill cap securely. If fluid was foamy, repeat steps 4. and 5. until fluid no longer foams.

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Closed Cooling System

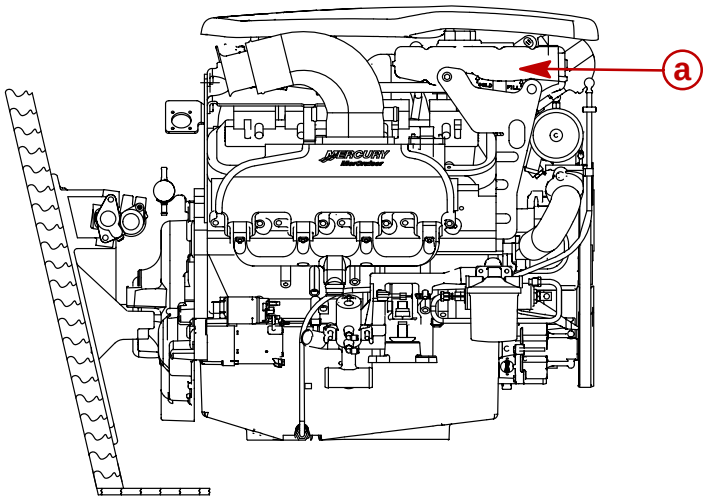
Checking Coolant Level

⚠ WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and remove cap

IMPORTANT: When reinstalling pressure cap, be sure to tighten it securely.

1. Coolant level should be at the FULL mark on coolant reservoir with the engine at normal operating temperature.



77625

a - Coolant Reservoir

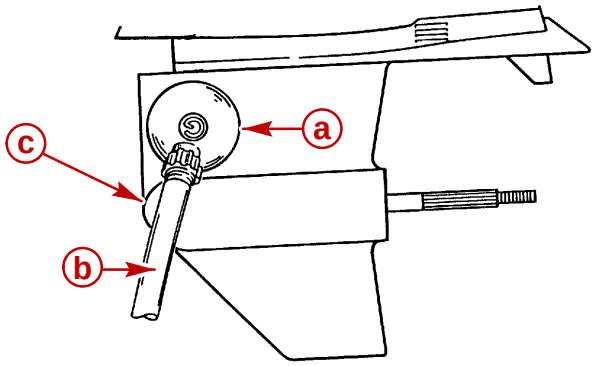
Flushing System MCM (Sterndrive)

If engine is operated in salty, polluted or mineral-laden water, flush cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush cooling system prior to storage.

NOTE: *For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.*

IMPORTANT: Low water pickups must be suitably blocked during flushing to ensure proper water flow to engine.

1. If boat is in water, raise drive unit to full UP position.
2. Install flushing attachment over water pickup holes in gear housing.
3. Attach a hose between the flushing attachment and a water tap.



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a - Flushing Attachment
b - Hose
c - Low Water Pickups (Hidden)

4. If drive was raised, lower drive unit to full IN position.

⚠ WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pick-up pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

5. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
6. Place remote control in NEUTRAL, idle speed position, and start engine.
7. Operate engine at idle speed in NEUTRAL for 10 minutes, or until discharge water is clear, then stop engine.
8. Shut off water tap.
9. Raise drive unit to full UP position.
10. Remove hose and flushing attachment.

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Flushing System MIE (Inboard)

⚠ CAUTION

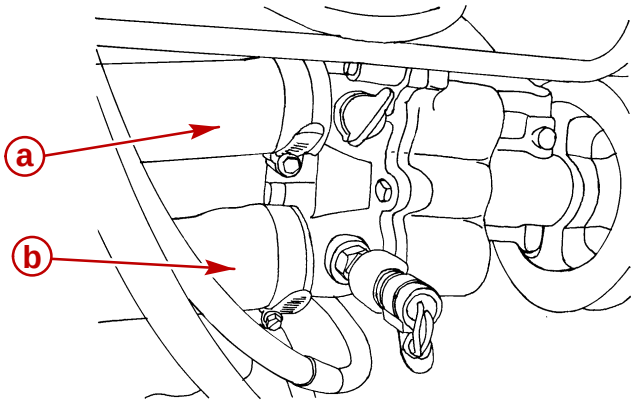
If boat is in the water, seacock, if equipped, must remain closed until engine is to be re-started, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must remain disconnected and plugged (to prevent water from flowing back into cooling system and/or boat). As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.

IMPORTANT: If a seacock is to be installed for this purpose, valve used must have an internal cross-sectional area equal to or greater than water inlet hose to prevent restricting water flow during normal operation. A 1-1/4 in. (32 mm), or larger, brass ball valve or gate valve is recommended.

⚠ CAUTION

Boats with water lift type exhaust collectors or mufflers: Engines must be running when flushing the cooling system to properly drain. If the engine is not run during flushing, the flushing water can fill up the collector or muffler and back up into the exhaust manifolds. The water can then enter the internal parts and cause serious damage.

1. If boat is in water, close seacock, if equipped, or disconnect and plug seawater inlet hose to prevent seawater from entering boat.
2. Remove inlet hose from seawater pickup pump.



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a - Seawater Inlet Hose
b - Seawater Outlet Hose

3. Using an adaptor, connect a hose from a water tap to seawater pump inlet.
4. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
5. Place the remote control lever in NEUTRAL, idle speed position and start engine.

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⚠ WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pick-up pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

6. Operate engine at idle speed in NEUTRAL for 10 minutes, or until discharge water is clear. Stop engine.
7. Shut off water tap. Remove water hose and adaptor from pump inlet and reconnect water inlet hose. Be sure to tighten hose clamp securely.

IMPORTANT: If boat is in the water, do not open water inlet valve until engine is to be restarted to prevent contaminated water from flowing back into engine. If boat is not fitted with a valve, leave water inlet hose disconnected and plugged.

Transmission Fluid

Checking Fluid Level

IMPORTANT: It may be necessary to adjust oil levels depending on installation angle and cooling systems (heat exchanger and fluid lines).

⚠ WARNING

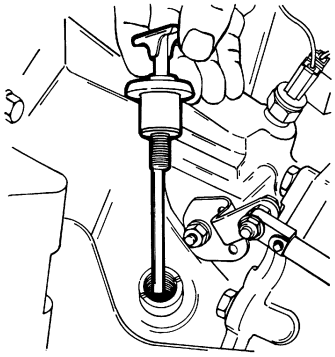
Do not remove dipstick with engine running. Hot oil can cause burns.

⚠ CAUTION

Clean around the area of the dipstick before removing. Small particles of dirt can cause damage to internal components and cause valves to stick.

IMPORTANT: DO NOT allow fluid level to drop below the bottom line.

IMPORTANT: DO NOT screw dipstick in.



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TRANSMISSION WARM

The transmission should be at operating temperature (190° maximum) to get an accurate oil level reading. Oil will expand when heated. Oil will drain back from the cooler. Expansion and drain-back can significantly affect oil level.

IMPORTANT: Oil level must be checked immediately after engine shut-down to prevent an incorrect reading. Oil drains back into the transmission from the cooler and cooler lines.

1. When the transmission is at operating temperature, place selector lever in NEUTRAL.
2. Shut off engine.
3. Remove dipstick and wipe clean.

IMPORTANT: Do not screw dipstick in; press it firmly in and remove.

4. Immediately insert clean dipstick and read oil level.
5. Add or remove oil as necessary until the oil is at the required mark.

TRANSMISSION COLD

NOTE: *For ease of checking the oil prior to engine start-up, a cold oil level mark can be made. To find the cold oil level mark, the oil level must first be set according to the warm oil level checking procedure.*

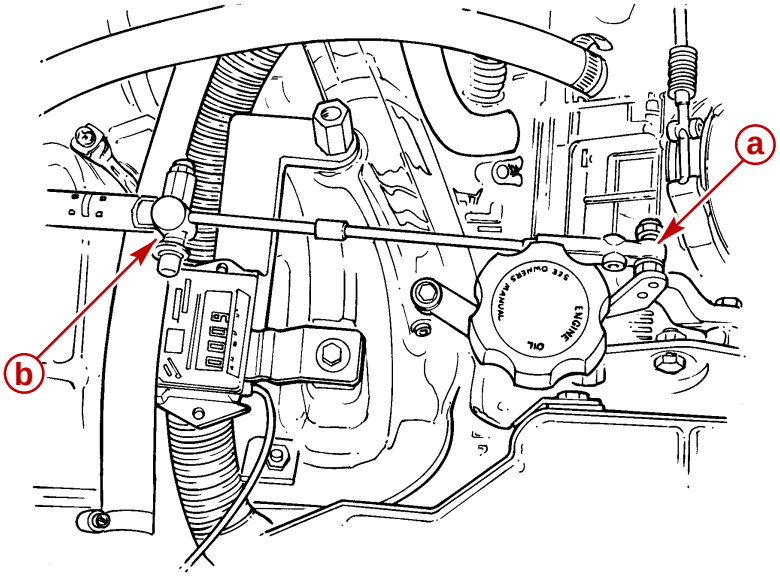
1. Let the boat sit overnight. Insert clean dipstick and read level.
2. Put a mark on the dipstick at the cold oil level.

NOTE: *You can use the new mark to check the oil level when cold. If oil level adjustment is needed, add oil to the new mark.*

Lubrication

Throttle Cable

MCM AND MIE MODELS



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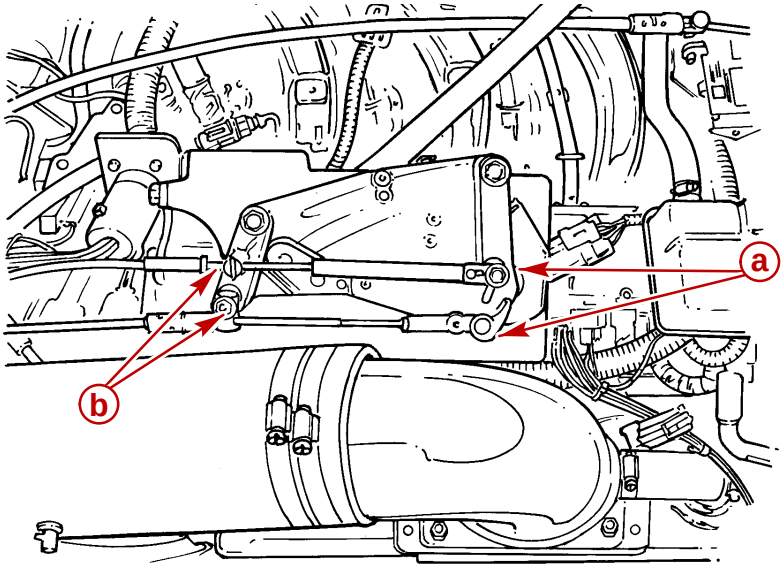
a - Pivot Points
b - Guide Contact Surface

Shift Cable

MCM MODELS



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a - Pivot Points
b - Guide Contact Surface

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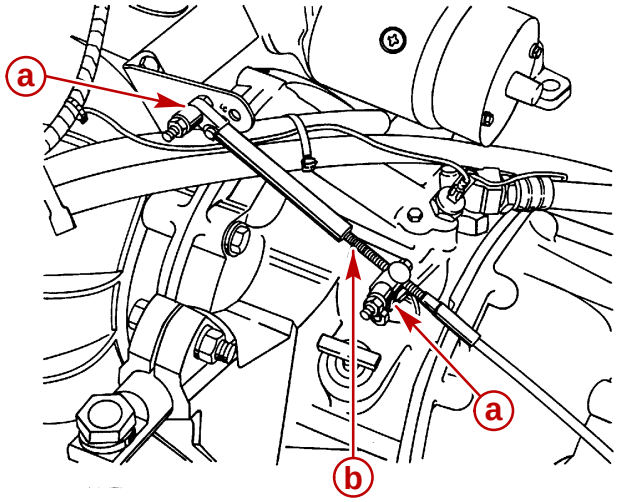
Shift Cable and Transmission Linkage

MIE MODELS



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Typical Shift Cable And Transmission Linkage

a - Pivot Points
b - Guide Contact Surface

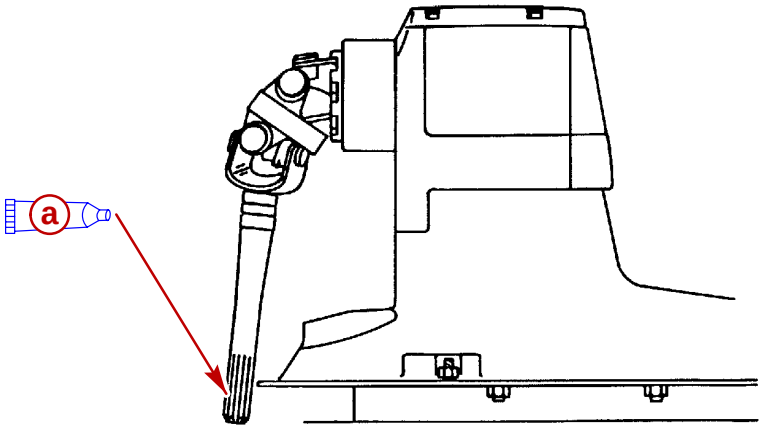
Engine Coupler / U-Joint Shaft Splines

MCM MODELS

NOTE: *Engine coupler and shaft splines are greased with Quicksilver Engine Coupler Spline Grease; universal joints are greased with Quicksilver 2-4-C Marine Lubricant.*

NOTE: *Refer to Mercury Mercruiser Sterndrive Service Manual for sterndrive unit removal and installation, if necessary.*

IMPORTANT: Sterndrive unit does not have to be removed to grease coupler.



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Typical Bravo Drive

a - Quicksilver Engine Coupler Spline Grease

Starter Motor

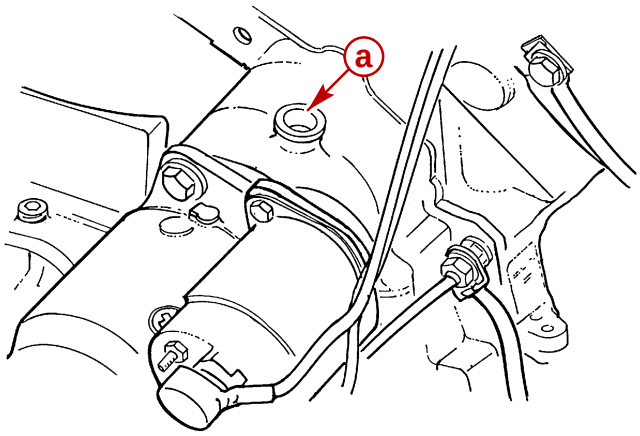
MIE MODELS

⚠ WARNING

When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of a fire.**
- **Stay clear of all moving parts.**

1. Disconnect both coil pack harness connectors. While cranking engine with starter motor, lubricate starter motor front bushing through oil cover with motor oil or equivalent.
2. Remove plastic plug from flywheel housing. Lubricate starter motor shaft with motor oil through hole in flywheel housing. Reinstall plastic plug.



72019

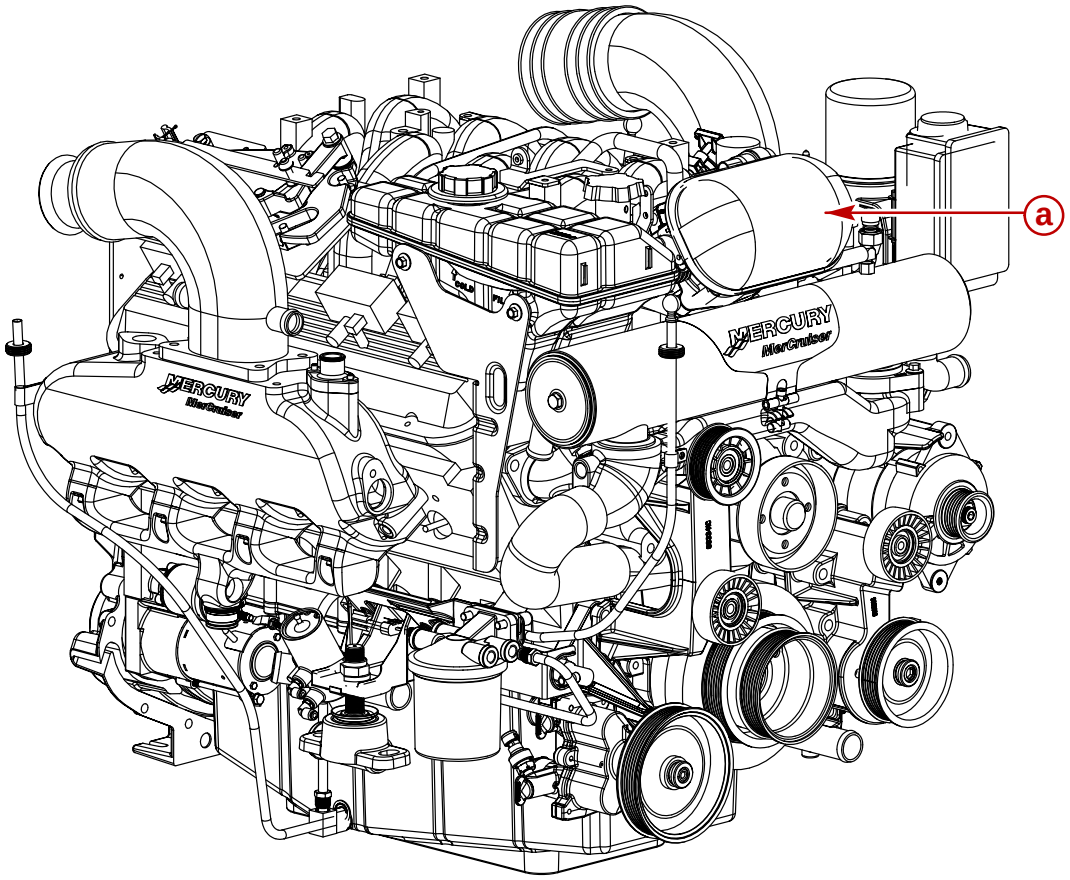
a - Plug-In Flywheel Housing Lubrication Point

Cleaning Flame Arrestor

⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. Be careful when cleaning flame arrestor. Be sure that ignition is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor. NEVER use gasoline as a cleaning solvent.

1. Remove engine cover.
2. Remove flame arrestor.
3. Clean flame arrestor in solvent. Dry with compressed air.
4. Reinstall flame arrestor.



77635

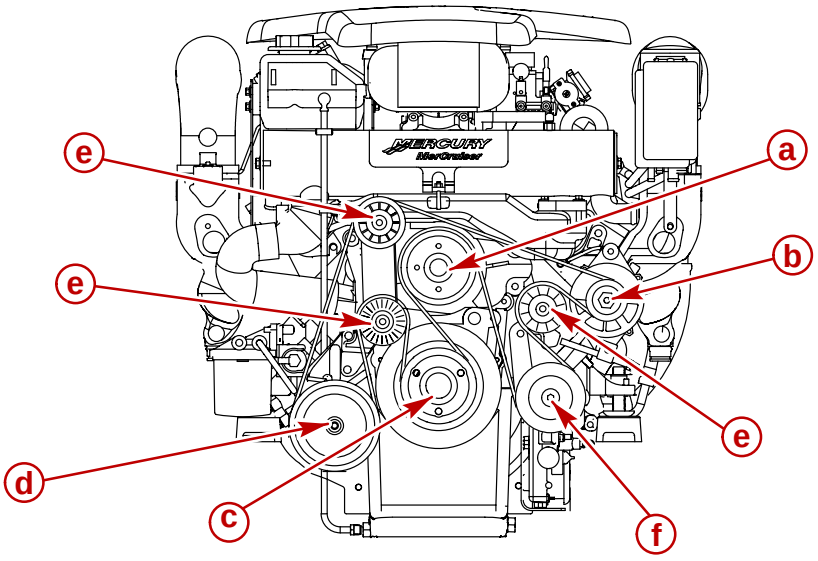
a - Flame Arrestor

Serpentine Drive Belt

Component Location

⚠ WARNING

Avoid possible serious injury. Ensure engine is shut off and ignition key is removed before inspecting belt.



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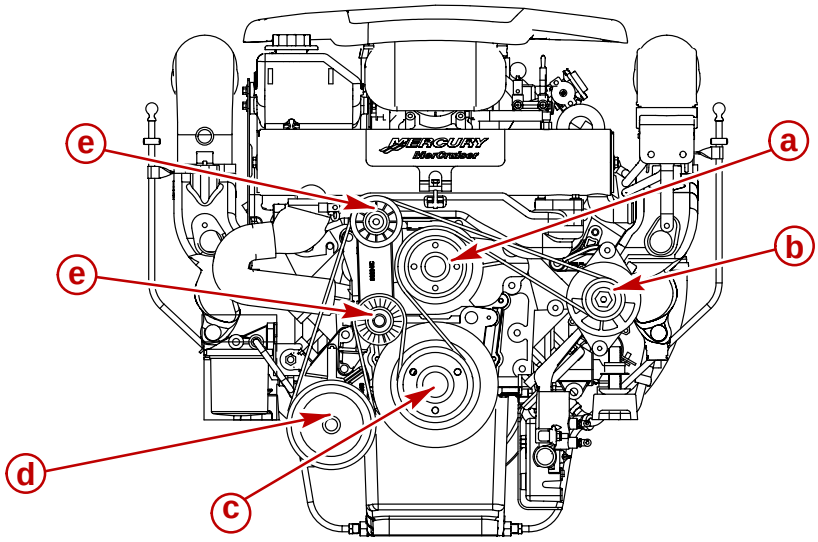
MCM



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MIE

- **a** - Water Circulating Pump
- **b** - Alternator
- **c** - Crankshaft
- **d** - Seawater Pump
- **e** - Idler
- **f** - Power Steering

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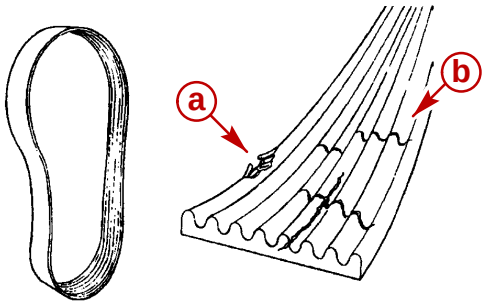
Inspection

1. Inspect drive belt for the following:

- Excessive wear
- Cracks

NOTE: Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in direction of belt length) that join transverse cracks are NOT acceptable.

- Fraying
- Glazed surfaces



75130

a - Fraying
b - Cracks

Removal

1. Loosen alternator attaching bolt.
2. Loosen tension bolt retainer nut.
3. Loosen tension bolt.
4. Move alternator to relieve tension on drive belt.

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

5. If belt is to be reused, mark direction of rotation.
6. Remove belt.

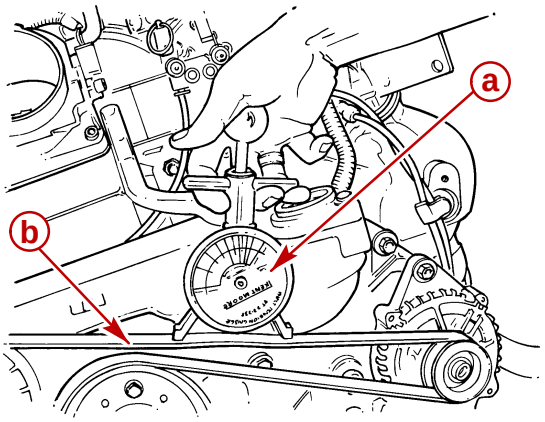
Installation

1. Install drive belt on pulleys.
2. Position tension bolt into idler pulley bracket.
3. Tighten tension bolt until belt is taut.

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys.*

4. Check belt deflection between the upper idler pulley and the alternator pulley using one of the following methods.

   a. Attach Kent Moore Belt Tension Gauge to belt. Gauge has different ranges for new and used belts.



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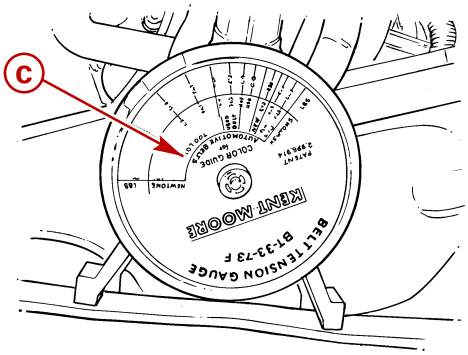


77574

a - Kent Moore Tension Gauge
b - Serpentine Belt
c - Dial Gauge On Belt Tension Tool

   b. If tool is not available, belt deflection can be checked by applying moderate downward pressure on belt. Proper deflection is approximately 1/4 in. (6 mm).

5. Securely tighten tension stud retainer nut.
6. Tighten alternator attaching bolt and nut.

Cold Weather or Extended Storage

Precautions

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF and do not smoke or allow sources of spark and/or open flames in the area.

⚠ WARNING

To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠ CAUTION

Seawater (Rawwater) section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

⚠ CAUTION

If boat is in the water, seacock (water inlet valve), if equipped, must be left closed until engine is to be started to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.

⚠ CAUTION

Sterndrive unit should be stored in full DOWN position. Universal Joint bellows may develop a set if unit is stored in raised position and may fail when unit is returned to service.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

⚠ CAUTION

Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely. Refer to Fluid Recommendations for more information.

⚠ CAUTION

A discharged battery can be damaged by freezing.

Power Package Layup

NOTICE

Refer to Cold Weather or Extended Storage Precautions in this section BEFORE proceeding.

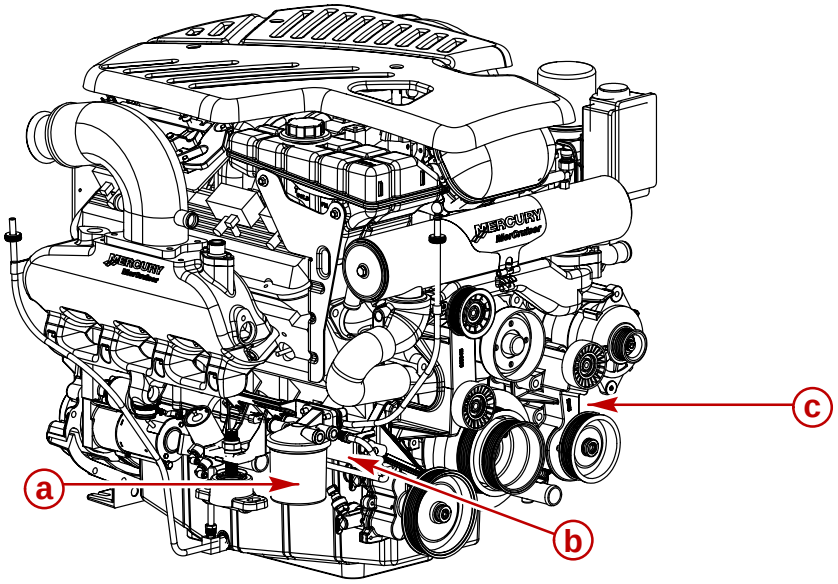
1. Fill fuel tanks with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat gasoline. Follow instructions on container.
2. **If boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained as low as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to Fuel Recommendations for additional information.

NOTE: *If desired, a portable fuel tank can be used to perform the remainder of the power package layup procedures. Be sure to add an appropriate amount of Gasoline Stabilizer to the portable tank.*

IMPORTANT: Before starting engine, a water source must be attached to the seawater pickup pump. Follow all warnings and flushing attachments procedures stated in FLUSHING COOLING SYSTEM.

3. Run engine sufficiently to bring it up to normal operating temperature and allow fuel with Quicksilver Gasoline Stabilizer to circulate through fuel system. Shut off engine.
4. Change oil and oil filter. Refer to Changing Oil And Filter.
5. Flush cooling system. Refer to Flushing System.
6. Close the fuel shut-off valve, if equipped. If no fuel shut-off valve is present, a suitable method must be employed to STOP the flow of fuel from the fuel tank to the engine before proceeding.

7. Prepare fuel system for extended storage as follows:
   a. Allow engine to cool down.
   b. Remove the water separating fuel filter.
   c. Pour out a small amount of fuel into a suitable container, then add approximately 2 fluid ounces (60 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the water separating fuel filter.
   d. Reinstall water separating fuel filter.
   e. Disconnect harness connections from fuel pump and fuel boost pump.



77629

a - Water Separating Fuel Filter
b - Fuel Boost Pump
c - Fuel Pump (Hidden)

   f. Start and operate engine at idle speed until the water separating fuel filter and fuel injection system are empty and engine stops.
   g. Remove and discard water separating fuel filter.
   h. Install new water separating fuel filter.
   i. Reconnect harness connections at both fuel pumps.
8. Clean flame arrestor.
9. Lubricate all items listed in Lubrication section.
10. Drain seawater section of cooling system.
11. Test coolant to ensure that it will withstand the lowest temperature expected during storage.
12. Service batteries.
13. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
14. For sterndrive unit layup, refer to appropriate sterndrive service manual.

Draining

NOTE: *If recommended coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require replacement every two years.*

IMPORTANT: Drain seawater section of closed cooling system only.

IMPORTANT: Boat must be as level as possible to ensure complete draining of cooling system.

⚠ CAUTION

Seawater section of cooling system MUST BE COMPLETELY drained for winter storage or immediately after cold weather use if the possibility of freezing temperatures exist. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine. Damage caused by freezing IS NOT covered by the Mercury MerCruiser Limited Warranty.

⚠ CAUTION

If engine will be exposed to freezing temperatures, ensure closed cooling section is filled with an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

IMPORTANT: Closed cooling section must be kept filled year-round with recommended coolant.

IMPORTANT: Do not use Propylene Glycol Antifreeze in the closed cooling section of the engine.

⚠ CAUTION

Ensure that boat is out of the water or seacock is closed and that bilge pump is operating. Excess water in the bilge can damage engine or cause boat to sink.

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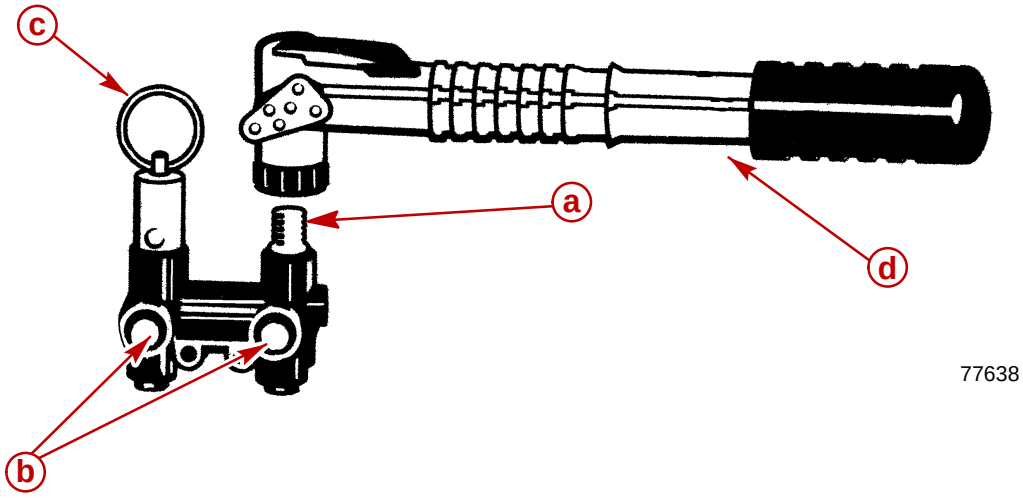
SINGLE POINT DRAIN SYSTEM

⚠ CAUTION

Freeze damage can occur if operating where temperatures are below 32° F. Use Manual Drain System to ensure heat exchanger is completely drained.

NOTE: *This procedure is written for the air pump that is attached to the engine. However, any air source can be used.*

1. Remove air pump from engine.
2. Ensure that lever on top of pump is flush with the handle (horizontal).
3. Install air pump on the actuator fitting.



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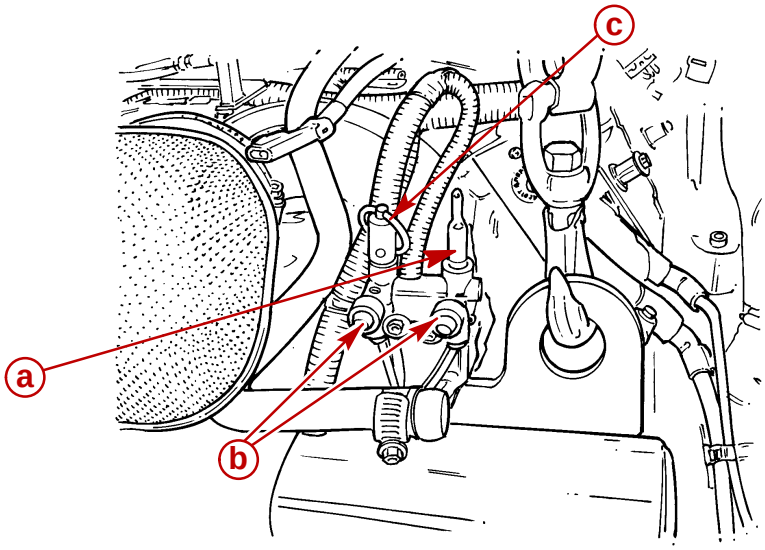

77516

a - Actuator Fitting
b - Green Indicators
c - Manual Release Valve
d - Air Pump

4. Pull lever on air pump up (vertical) to lock pump on actuator fitting.

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5. Pump air into the system until both green indicators extend and water drains from both sides of the engine.
6. Most water will drain from the engine in 3-4 minutes, however, some will remain trapped in the heat exchanger. In order to prevent freeze damage, leave system pressurized while transporting boat or during other maintenance items to allow the remaining water to drain.

IMPORTANT: Before launching boat, pull up on manual release valve. Verify that green indicators are no longer extended.

⚠ CAUTION

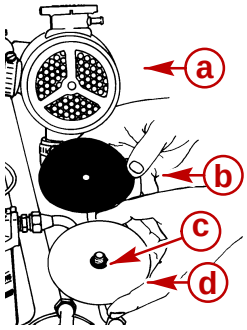
Manual release valve may not close completely. Ensure valve is completely seated.

MANUAL DRAIN SYSTEM

NOTE: *If air actuated drain system fails, use the blue drain plugs to drain engine.*

NOTE: *It may be necessary to lift, bend or lower hoses to allow water to drain completely when hoses are disconnected.*

1. Remove blue drain plugs from front and rear of cool fuel cell and from the seawater pump.
2. Remove end caps, sealing washers and gaskets from heat exchangers.



71515

a - Heat Exchanger
b - Gaskets
c - Sealing Washer
d - End Cap

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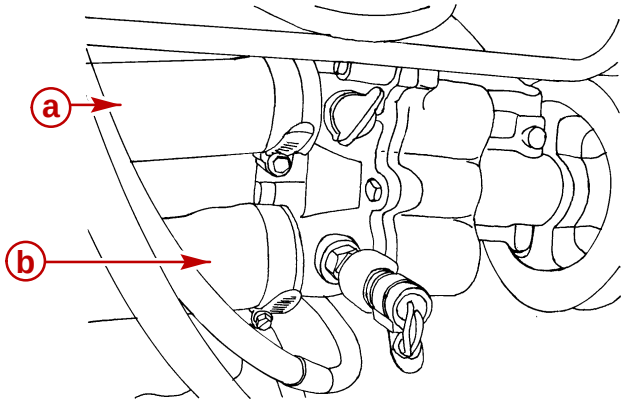
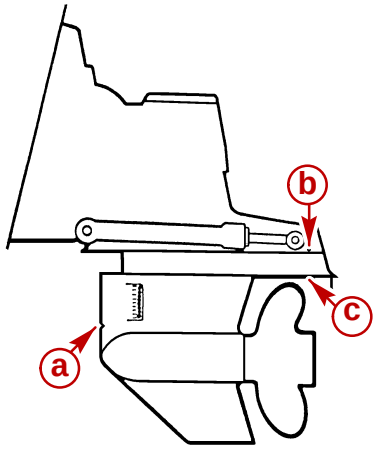
3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.
4. Remove both hoses from seawater pump.



77512

a - Seawater Inlet Hose
b - Seawater Outlet Hose

5. **MCM Only:** Insert a small wire (repeatedly) to make sure that speedometer pitot tube, trim tab cavity vent hole and trim tab cavity drain passage are unobstructed and drained.



71217

Typical Bravo Drive Unit

a - Speedometer Pitot Tube
b - Anode Cavity Vent Hole
c - Anode Cavity Drain Passage

6. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

Recommissioning

NOTICE

Refer to Cold Weather or Extended Storage Precautions BEFORE proceeding.

1. Verify that all cooling system hoses are connected and tight and all drain plugs are installed and tight.

IMPORTANT: Before launching boat, pull up on manual release valve. Verify that green indicators are no longer extended.

2. Pull up on manual release valve to release pressure from the drain system.

⚠ CAUTION

Manual release valve may not close completely. Ensure valve is completely seated.

3. Verify that air actuator and water drain system pressure indicators have returned to the closed position and that the manual relief valve is completely closed.
4. Inspect serpentine drive belt condition and tension.
5. Perform all lubrication and maintenance specified for completion annually in maintenance schedule, except items which were performed at time of engine layup.
6. For sterndrive unit recommissioning, refer to appropriate sterndrive service manual.

⚠ CAUTION

When installing battery (in next step), be sure to connect positive battery cable to positive (+) terminal and negative (grounded) battery cable to negative (–) battery terminal. If battery cables are reversed, damage to electrical system WILL result.

7. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

8. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
9. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
10. Check steering system, shift and throttle controls for proper operation.

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IMPORTANT INFORMATION

Section 1C - Troubleshooting

1 C

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Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor, gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor. Wipe up any spilled fuel immediately.

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT overtighten.**
- **Install fuel line. To prevent overtightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

⚠ CAUTION

Supply water to seawater pickup pump before operating engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. To operate engine with boat out of water, refer to Running Engine with Boat Out of Water.

⚠ WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠ CAUTION

DO NOT run engine above 1500 rpm. Suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

⚠ WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

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Poor Boat Performance and/or Poor Maneuverability

Symptom	Cause
Bow too low	Improper sterndrive unit trim angle
	Improper weight distribution
	Boat is underpowered
	Permanent or power hook in boat bottom
	False bottom full of water
	Improperly adjusted anode (after planes)
	Dirty boat bottom (marine growth)
Bow too high	Improper sterndrive unit trim angle
	Propeller pitch too great
	Dirty boat bottom (marine growth)
	Poor engine performance
	Improper weight distribution
	Rocker in boat bottom
	False bottom full of water
	Improperly adjusted anode (after planes)
Propeller ventilating	Sterndrive unit installed too high on transom
	Dirty or damaged boat bottom
	Damaged propeller; pitch too small; diameter too small
	Keel located too close to propeller or too deep in the water
	Water pickup or through hull fittings located too close to propeller
	Hook in boat bottom
	Propeller plugged up with weeds

Improper Full Throttle Engine RPM

RPM Too High

Cause	Special Information
Propeller	Damaged; pitch too low; diameter too small; propeller hub slipping.
Boat	Water pickup or through hull fittings mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Sterndrive unit installed too high on transom; wrong gear ratio.
Operation	Sterndrive unit trimmed out too far.
Engine coupler slipping	

RPM Too Low

Cause	Special Information
Propeller	Damaged; pitch too great; diameter too great.
Boat	Dirty or damaged boat bottom; permanent or power hook in bottom; false bottom full of water. Sterndrive unit installed too low on transom; wrong gear ratio.
Operation	Sterndrive unit trimmed in too far.

Engine Cranks Over But Will Not Start Or Starts Hard

Important Information

1. First, determine which engine system is causing the problem. To make an engine operate fuel, spark (ignition) and compression are required. If all three components are present, the engine should run. If any one of the three are missing, weak or out of sync engine will not run.
2. Check ignition system operation. Remove spark plug wire from coil pack. Hold spark plug wire near ground and check for spark while cranking engine over. Repeat procedure with each spark plug wire. If there is spark at the spark plug wires, remove the spark plugs and ensure that they are correct type and heat range, and not fouled or burned.
3. Run a compression check on engine.

Fuel System Rich

Cause	Special Information
Clogged flame arrestor	
Excessive fuel pump pressure	
Fuel pressure regulator defective	

Fuel System Lean

Cause	Special Information
Empty fuel tank	
Fuel shut-off valve closed (if equipped)	
Vapor lock	Engine will not start after warm engine shut down

Miscellaneous

Cause	Special Information
Low grade or stale fuel	
Water in fuel	
IAC Faulty	

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Engine Will Not Crank Over

Cause	Special Information
Remote control lever not in NEUTRAL position	
Battery charge low; damaged wiring; loose electrical connections	
Circuit breaker tripped	
Blown fuse	
Ignition switch	
Slave solenoid	
Faulty neutral start safety switch	Open circuit
Starter solenoid	
Starter motor	
Mechanical engine malfunction	

Charging System Inoperative

Cause	Special Information
Loose or broken serpentine belt	
Engine rpm too low on initial start	Rev engine to 1500 rpm
Loose or corroded electrical connections	
Faulty battery gauge	Best way to test is to replace gauge
Battery will not accept charge	Low electrolyte or failed battery
Faulty alternator or regulator	
Refer to SECTION 4C for complete Charging System diagnosis procedures	

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Noisy Alternator

Cause	Special Information
Loose mounting bolts	
Drive belt	Worn, frayed, loose
Loose drive pulley	
Worn or dirty bearings	
Faulty diode trio or stator	

Instrumentation Malfunction

Cause	Special Information
Faulty wiring, loose or corroded terminals	
Faulty key switch	
Faulty gauge	
Faulty sender	

Radio Noise

Cause	Special Information
A popping noise that will increase with engine rpm. Noise will stop as soon as engine is turned off.	Ignition System - wrong spark plugs; leaking spark plug wires; moisture on ignition components
High pitched whine in the radio	Alternator - poor brush contact on the slip rings
A hissing or crackling noise when instruments are jarred with ignition on	Instrumentation - loose connections, or antennae wire routed too close to instruments
Varying unexplained noises	Accessories - bilge pump, bilge blower; fish finder, depth locator; cabin heater motor, etc. Disconnect one at a time until noise disappears.

Poor Fuel Economy

Cause	Special Information
Fuel leaks	
Operator habits	Prolonged idling; slow acceleration; failure to cut back on throttle once boat is on plane; boat overloaded; uneven weight distribution
Engine laboring	Bent, damaged, or wrong propeller. Water test boat for proper operating rpm at wide open throttle
Clogged flame arrestor	
Engine compartment sealed too tight	Not enough air for engine to run properly
Boat bottom	Dirty (marine growth), hook, rocker
Improper fuel	
Engine running too cold or too hot	
Plugged or restricted exhaust	
Engine	Low compression

Engine Runs Poorly at Idle

Symptoms	Cause
Engine surges	Refer to Fuel Injection Troubleshooting
Low top speed or lack of power	
Poor cold engine operation	
Engine stalls	
Hard starting	Refer to Engine Starts Hard

Engine Runs Poorly At High RPM

Cause	Special Information
Also refer to Poor Boat Performance	
Crankcase overfilled with oil	Check oil level with boat at rest in the water.
Anti-siphon valve	Restricting fuel supply
Plugged fuel tank vent	
Fuel supply	Refer to Fuel Injection Troubleshooting
Low grade of fuel or water in the fuel	
Spark plugs	Fouled, burned, cracked porcelain, incorrect heat range
Spark plug wires	Poor insulation, broken wires
Coils malfunctioning	
Engine overheating	Refer to Engine Overheats
Low compression	Worn valves, rings, cylinders
Restricted exhaust	

Engine Acceleration Is Poor

Cause	Special Instructions
Also refer to Poor Boat Performance	
Vacuum leak	Intake manifold
Spark plugs	Fouled, burned; wrong heat range; cracked porcelain
Low compression	

Troubleshooting with Vacuum Gauge

Reading	Cause
Steady reading between 15-21 inches at idle rpm	Normal
Extremely low reading, but steady at idle rpm	Vacuum leak; underpowered boat; boat bottom damaged or incorrectly manufactured
Fluctuates between high and low at idle rpm	Blown head gasket between two adjacent cylinders
Fluctuates 4 or 5 inches very slowly at idle rpm	Spark plug gap too narrow, valves are sticking
Fluctuates rapidly at idle, steadies as rpm is increased	Valve guides are worn
Continuously fluctuates between low and normal reading at regular intervals at idle rpm	Burned or leaking valve

Engine Noise

Important Information

No definite rule or test will positively determine source of engine noise. Use the following information as a general guide to engine noise diagnosis.

1. Noises timed with engine speed are related to crankshaft, rods, pistons, piston pins and flywheel. Noises timed to 1/2 engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source. However, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and loose flywheel cover. In many cases if this is found to be the problem, a complete engine teardown is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required.
7. If noise cannot be distinguished between engine and drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

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Valve Cover Area

Location	Possible Causes
Valve cover area, timed to 1/2 engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders	Rocker arm striking valve cover
	Rocker arm out of adjustment
	Worn rocker arm
	Bent push rod
	Collapsed lifter

Cylinder Area

Location	Possible Causes
Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	Sticking valve
	Carbon build-up
	Connecting rod installed wrong
	Bent connecting rod
	Piston
	Piston rings
	Piston pin
	Cylinder worn

Camshaft Area

Location	Possible Causes
Camshaft area, front of engine, timed to 1/2 engine speed	Crankshaft timing sprocket
	Timing chain
	Valve Lifter
	Cam Bearings
Camshaft area, center of engine, timed to 1/2 engine speed	Fuel Pump
	Valve Lifter
	Cam bearing
Camshaft area, rear of engine, timed to 1/2 engine speed	Oil drive gear
	Valve lifter
	Cam bearings
Camshaft area, throughout engine, timed to 1/2 engine speed	Loss of oil pressure
	Camshaft Sensor
	Valve lifters
	Cam bearings

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Crankshaft Area

Location	Possible Causes
Crankshaft area, front of engine, timed to engine speed	Crankshaft timing sprocket
	Timing chain
	Main bearing
	Rod bearing
Crankshaft area, center of engine, timed to engine speed	Crankshaft striking pan or pan baffle
	Main bearing
	Rod bearing
Crankshaft area, rear of engine, timed to engine speed	Loose flywheel cover
	Loose coupler
	Loose flywheel
	Main bearing
	Rod bearing
Crankshaft area, throughout engine, timed to engine speed	Loss of oil pressure
	Main bearings
	Rod bearings

Miscellaneous

Noise	Possible Cause
Engine spark knock	Low octane fuel
	Engine running hot
	Carbon deposits in engine
Hissing	Vacuum leak
	Leaking exhaust (manifolds or pipes)
	Loose cylinder heads
	Blown head gasket
Whistle	Vacuum leak
	Dry or tight bearing in an accessory
Sparks jumping	Leaking high tension lead
	Cracked coil tower
Squeaks or squeals	Serpentine drive belt slipping
	Dry or tight bearing in an accessory
	Parts rubbing together
Rattling in exhaust pipe area	Exhaust shutters

Oil Pressure

Miscellaneous

Cause	Special Information
Measuring oil pressure	Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
Check engine oil level with boat at rest in the water	Oil level should be between the ADD and FULL or OK RANGE marks
Oil level in crankcase above FULL or OK RANGE mark	May cause loss of engine rpm, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high rpm
Oil level in crankcase below ADD mark	Low oil pressure; oil pressure gauge fluctuation; internal engine noise and/or damage
Change in oil pressure	This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal opening temperature, it is normal for oil pressure to drop.
Low engine oil pressure at idle	With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not clatter (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will thin somewhat from heat.
Low engine oil pressure at idle after running at a high rpm	Refer to the two preceding steps
Boats with dual engines	It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders.
Boats with dual stations	

Low Oil Pressure

Cause	Special Information
Low oil level in crankcase	
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge.
Thin or diluted oil	Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation)
Oil pump	Relief valve stuck open; pickup tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pickup oil tube
Oil leak can be internal or external	Oil passage plugs leaking, cracked or porous cylinder block
Excessive bearing clearance	Cam bearings, main bearings, rod bearings

High Oil Pressure

Cause	Special Information
Oil too thick	Wrong viscosity, oil full of sludge or tar
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge
Clogged or restricted oil passage	
Oil pump relief valve stuck closed	

Excessive Oil Consumption

Cause	Special Information
Normal consumption	One quart of oil consumed in 5-15 hours of operation at wide-open-throttle (especially in a new or rebuilt engine) is normal
Oil leaks	Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
Oil too thin	Oil diluted or wrong viscosity
Oil level too high	
Drain holes in cylinder head plugged	Oil will flood valve guides
Defective valve seals	
Intake manifold gasket leaking	
Worn valve stems or valve guides	
Defective oil cooler	Crack in cooler tubes
Defective piston rings	Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap
Defective cylinders	Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston
Excessive bearing clearance	

Water In Engine

Important Information

IMPORTANT: First determine location of water in engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are: water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons.

The first step, after locating water, is to remove all the water from the engine by removing all spark plugs and pumping cylinders out by cranking engine over. Change oil and filter. Replace spark plugs. Start engine and see if problem can be duplicated. If problem can be duplicated, there is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If the water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge, or condensation.

If the water is located in both the cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered these areas.

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Water on Top of Pistons

Cause	Special Information
Operator shut engine off at high rpm	
Engine diesels or tries to run backwards	Poor fuel, high idle rpm
Rain water running into flame arrestor	Hatch cover
Spark plug misfiring	Improper combustion causes moisture in the air to accumulate in the cylinder
Backwash through the exhaust system	
Improper engine or exhaust hose installation	
Cracked exhaust manifold	
Improper manifold to elbow gasket installation	
Loose cylinder head bolts	
Blown cylinder head gasket	Check for warped cylinder head or cylinder block
Cracked valve seat	
Porous or cracked casting	Check cylinder heads, cylinder block, and intake manifold

Water in Crankcase Oil

Cause	Special Information
Water in boat bilge	Boat has been submerged or bilge water was high enough to run in through dipstick tube
Water seeping past piston rings or valves	Refer to Water in Engine (On Top of Pistons)
Engine running cold	Defective thermostat, missing thermostat; prolonged idling in cold water
Intake manifold leaking near a water passage	
Cracked or porous casting	Check cylinder head, cylinder block, and intake manifold

Engine Overheats

Mechanical

Cause	Special Information
Engine rpm below specifications at wide open throttle (engine laboring)	Damaged or wrong propeller; growth on boat bottom; false bottom full of water
Spark plug wires crossed (wrong firing order)	
Lean fuel mixture	
Wrong heat range spark plugs	
Exhaust restriction	
Valve timing off	Jumped timing chain, or improperly installed
Blown head gasket(s)	A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low rpm, but will overheat at speeds above 3000 rpm.
Insufficient lubrication to moving parts of engine	Defective oil pump, plugged oil passage, low oil level

Engine Overheats

Cooling System

Cause	Special Information
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty. **IMPORTANT: Best way to test gauge or sender is to replace them.**	
Loose or broken drive belt	
Seawater shutoff valve partially or fully closed (if equipped)	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet (models with belt driven seawater pump only)	Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
Seawater inlet hose kinked or collapsed	
Seawater pickup clogged	
Obstruction on boat bottom causing water turbulence	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Defective thermostat	
Exhaust elbow water outlet holes plugged	
Insufficient seawater pump operation	Worn pump impeller
Obstruction in cooling system such as casting flash, sand, rust or salt	Refer to water flow diagram for engine type being serviced
Engine circulating pump defective	
Also refer to Engine Overheats - Mechanical	
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
Low coolant level	
Antifreeze not mixed properly	Antifreeze should be mixed 50/50 or maximum 60/40 (60% antifreeze, 40% water)
Heat exchanger cores plugged	
Water hoses reversed at the water distribution block	Refer to water flow diagram in SECTION 6

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Insufficient Water Flow from Belt Driven Seawater Pickup Pump

Cause	Special Information
Drive belt	Loose, worn or broken
Seawater shutoff valve partially or fully closed	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet	Pump will suck air, pump may fail to prime or will force air bubbles into cooling system
Seawater inlet hose kinked or plugged	
Seawater pickup plugged	
Obstruction on boat bottom causing water turbulence.	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Faulty seawater pump	

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Power Steering

Poor, Erratic or No Assist

Cause	Special Information
Drive belt	Worn, broken or out of adjustment
Low fluid level	
Air in system	Air leak in lines, pump, or air from installation. Refer to SECTION 9A
Leaking hoses	Refer to SECTION 9A
Steering cables and/or steering helm	Cable or helm partially frozen from rust or corrosion; cable over-lubricated; improper cable installation.
Binding in sterndrive unit	Refer to appropriate Sterndrive Service Manual
Restriction in hydraulic hoses	Causes a loss of pressure
Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
Mounting bracket adjusting screw loose or mounting tube is loose	
Faulty pump	Flow control valve may be sticking
Worn piston ring or scored housing bore in cylinder.	Causes loss of pressure
Leaking valve body or loose fitting spool	

Noisy Pump

Cause	Special Information
Drive belt	Check belt tension
Low fluid level	
Air in fluid	Air leak in lines, pump, or air from installation
Faulty pump	Use stethoscope to listen for noise in pump
Restricted fluid passages	Kinks or debris in hoses or debris in passages
Stop nut adjusted improperly	Refer to appropriate Sterndrive Service Manual
Steering cables installed that do not meet BIA standards	Refer to appropriate Sterndrive Service Manual

Fluid Leaks

Cause	Special Information
Loose hose connections	Refer to SECTION 9A
Damaged hose	
Oil leaking from top of pump	System overfilled; fluid contains water; fluid contains air
Cylinder piston rod seal	
Faulty seals in valve	
Faulty seals in O-rings in pump	
Cracked or porous metal parts	

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REMOVAL AND INSTALLATION

Section 2A - MCM Models

2 A

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Torque Specifications

Description		lb-in.	lb-ft	Nm
Drive Unit Shift Cable	Cable Barrel	Spread Cotter Key		
	Cable End Guide	See Note		
Hose Clamps		Securely		
Rear Engine Mounts			35-40	47-54
Power Steering Fluid Hose Fitting			23	31
Remote Control Shift Cables	Cable Barrel	Securely		
	Cable End Guide	See Note		
Remote Control Throttle Cable	Cable Barrel	Securely		
	Cable End Guide	See Note		

NOTE: *Tighten, then loosen nut 1/2 turn.*

Tools

Description	Part Number
Quicksilver Engine Alignment Tool	91-805475A1
Quicksilver Lifting Eye Tool	91–863375

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver U-Joint and Gimbal Bearing Grease	92-828052A2
Quicksilver Engine Coupler Spline Grease	91-816391A4
Quicksilver Liquid Neoprene	92-25711--3
Loctite Pipe Sealant With Teflon	Obtain Locally

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Removal

IMPORTANT: Sterndrive unit must be removed prior to engine removal. Refer to Bravo Sterndrive Service Manual.

1. Disconnect battery cables from battery.
2. Remove engine cover.

⚠ CAUTION

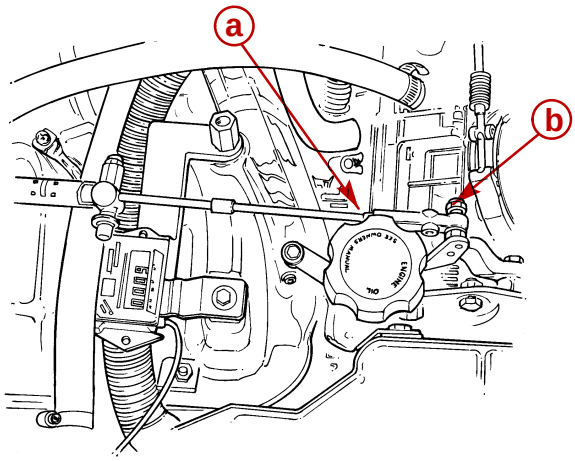
Engine compartment size may require the removal of additional components.

3. Loosen clamp and remove instrument wiring harness plug from engine harness receptacle.

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

4. Loosen hose clamp retaining fuel line to fuel inlet.
5. Close fuel shut off, if equipped. Disconnect and plug fuel line to prevent fuel in line from leaking into bilge.
6. Disconnect throttle cable from throttle body and retain locknuts and fasteners.



77597

a - Throttle Cable
b - Fasteners

7. Disconnect trim sender wire connection from engine harness.
8. Disconnect MerCathode wires from MerCathode controller if mounted on engine.
9. Disconnect seawater inlet hose from gimbal housing.
10. Disconnect exhaust system hoses.

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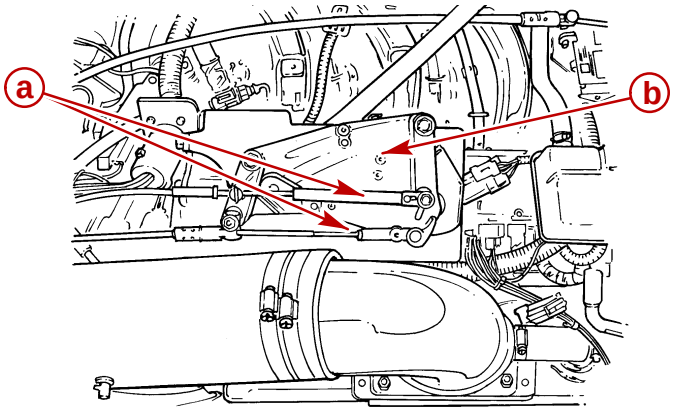
11. Remove both shift cables from shift plate. Retain locknuts and hardware.



77595

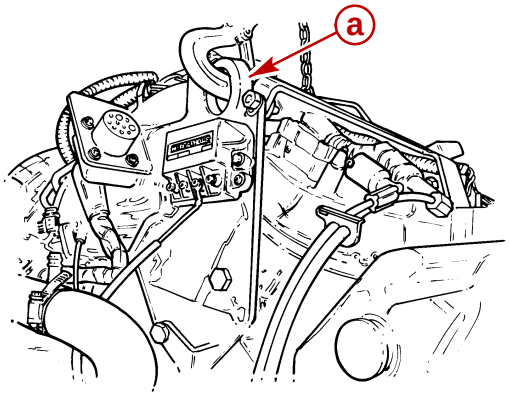
a - Shift Cables
b - Shift Plate

12. Disconnect any grounding wires and accessories that are connected to engine.
13. Disconnect (and suitably plug) fluid hoses from power steering control valve on transom.

⚠ CAUTION

Engine MUST be lifted with a hoist or damage to engine components will occur. DO NOT allow lifting sling to hook or compress engine components or damage will occur.

14. Support engine with suitable sling through lifting eyes on engine.



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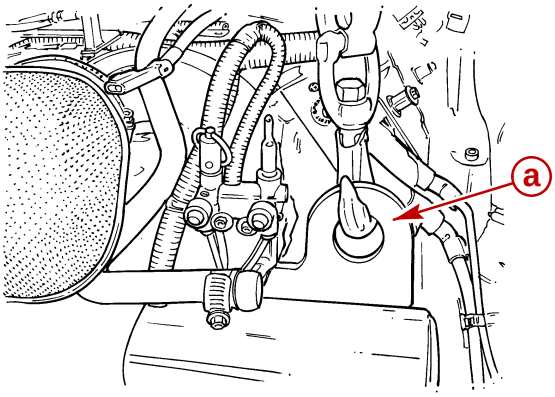

77516

a - Engine Lifting Eyes

15. Remove front and rear engine mounting bolts. Retain hardware.
16. Carefully remove engine. DO NOT hit power steering control valve.

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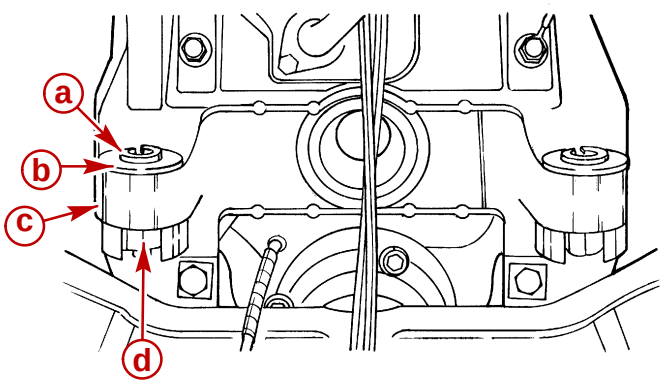
Installation

Engine Installation/Alignment

1. Be certain fiberwound lockwashers on inner transom plate are present. Inspect fiber washers. Replace if worn or damaged.
2. Install double wound lockwashers onto inner transom plate inside fiberwound lockwasher.
3. Be certain rear engine mount locknuts are in position.
4. Lubricate exhaust with soap and water to ease installation.
5. Lubricate engine coupler splines with Quicksilver Engine Coupler Spline Grease.



72023

a - Double Wound Lockwasher
b - Fiber Wound Lockwasher
c - Inner Transom Plate Mount
d - Locknuts

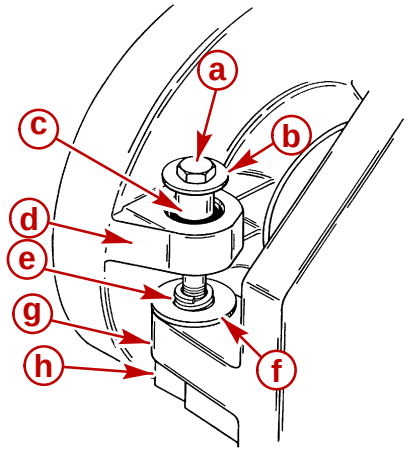
⚠ CAUTION

Engine MUST be lifted with a hoist or damage to engine components will occur. DO NOT allow lifting sling to hook or compress engine components or damage will occur.

6. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended.
7. Lift engine into position (in boat), using an overhead hoist.
8. Align rear engine mounts with inner transom plate mounts while simultaneously aligning exhaust tubes with exhaust pipe hoses.

IMPORTANT: Engine attaching hardware must be installed in sequence shown.

9. Install both rear engine mounting bolts and hardware as shown. Torque to 38 lb-ft (51 Nm).



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Typical Installation

- **a** - Rear Engine Mounting Bolt
- **b** - Large Steel Washer
- **c** - Metal Spacer
- **d** - Rear Engine Mount
- **e** - Double Wound Lockwasher
- **f** - Fiberwound Lockwasher
- **g** - Inner Transom Plate Mounts
- **h** - Locknut (Hidden)

⚠ CAUTION

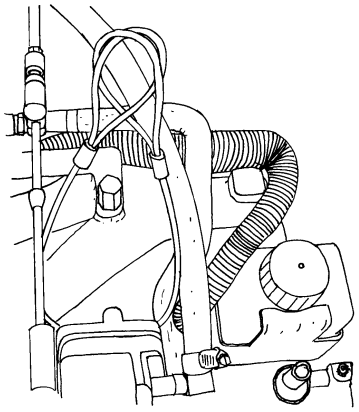
When lowering engine into position DO NOT set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

10. Set engine down on stringers and relieve hoist tension.

⚠ CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool 91-805475A1, may cause improper alignment and damage to gimbal bearing and/or engine coupler.

11. Attach center lifting eye tool to engine.



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12. Fasten hoist to center lifting eye tool to use for alignment.

⚠ CAUTION

To avoid damage to gimbal bearing, engine coupler or alignment tool:

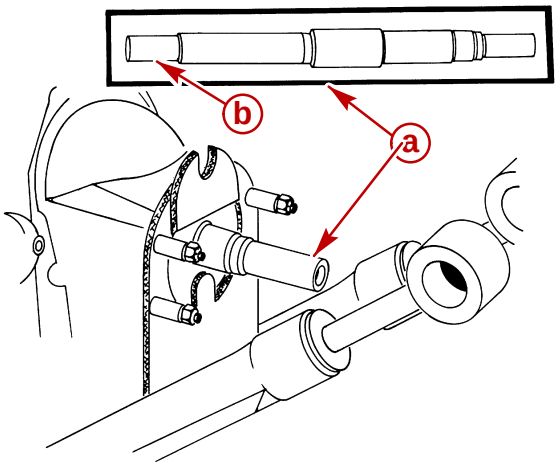
- **DO NOT attempt to force alignment tool!**
- **DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.**

13. Align engine as follows:

    a. Attempt to insert solid end of Quicksilver Alignment Tool through gimbal bearing and into engine coupler splines.

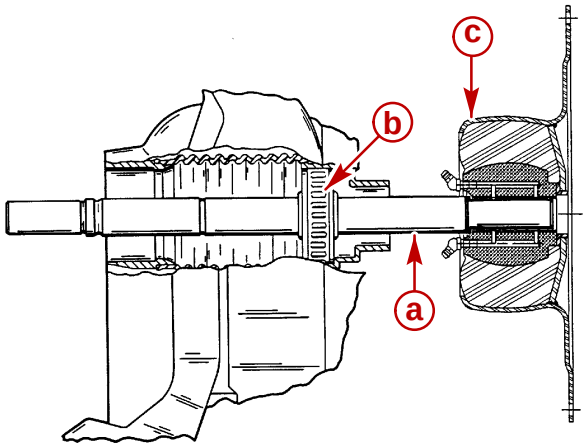
    b. If the alignment tool does not fit, remove it and carefully raise or lower the front end of the engine, as necessary, and attempt to insert the alignment tool.

c. Repeat step b. until the alignment tool installs easily. This may require tapping the sides of the tool. Do not check by turning. By greasing the splines you can identify which side has interference.



70013

a - Alignment Tool (Use Only Quicksilver Alignment Tool-91-805475A1)
b - Insert This End Of Alignment Tool Through Gimbal Housing Assembly



27647

a - Alignment Tool
b - Gimbal Bearing
c - Engine Coupler

IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

14. Adjust front engine mounts until they rest on boat stringers.
15. Relieve hoist tension entirely and fasten both front mounts to boat stringer using appropriate hardware.
16. Recheck alignment with alignment tool. Tool must enter coupler splines freely. If not, readjust front mounts.
17. When alignment is correct, tighten fasteners on each mount securely.

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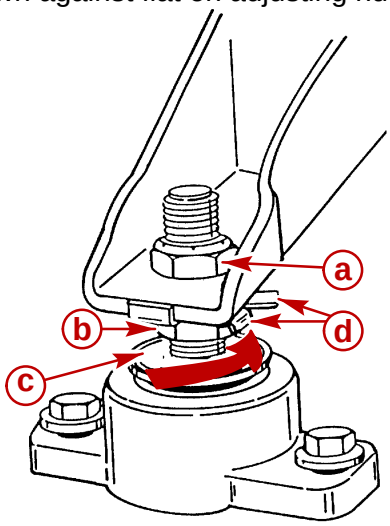
18. Bend tab washer down against flat on adjusting nut.



72922

a - Locknut
b - Adjustment Nut
c - Direction (Counterclockwise) To Raise Front Of Engine
d - Tab Washer

19. Remove alignment tool if not already removed.

20. Tighten all exhaust system hose clamps securely (use two hose clamps on each connection).

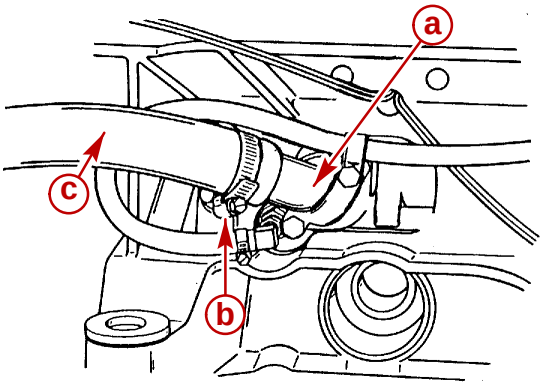
NOTICE (Through Transom Exhaust)
Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow. If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn through.

Water Hose Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater hose to water tube at gimbal housing with hose clamp. Tighten clamp securely.

NOTE: *The engine is not in position for visual clarity in this step.*



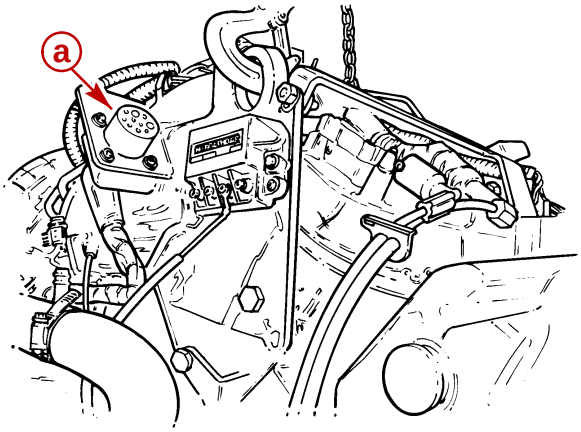
72590

a - Water Inlet Tube
b - Hose Clamp
c - Seawater Inlet Hose To Seawater Pump

Electrical Connections

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - Maintenance of this manual, or refer to the appropriate Mercury MerCruiser Sterndrive Service Manual.

1. Connect instrument wiring harness plug to engine wiring harness receptacle with hose clamp. Tighten clamp securely.



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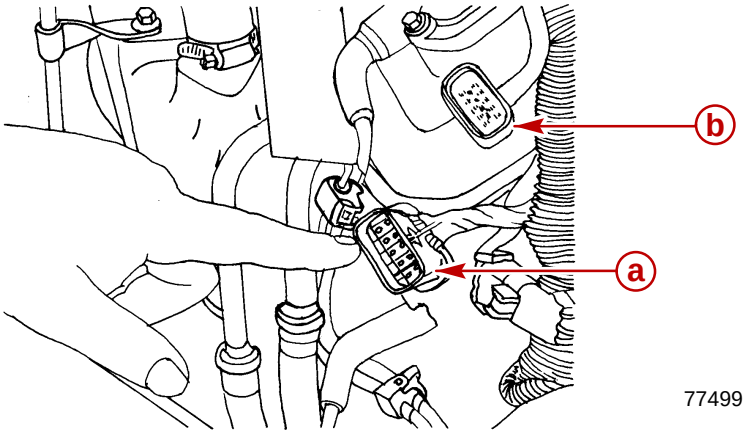
a - Engine Wiring Harness Receptacle

2. Connect transom harness.
3. Connect CAN line.

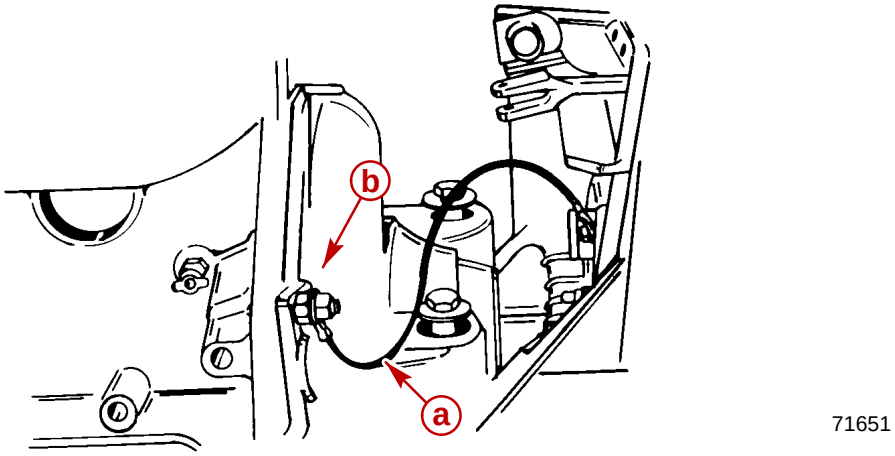


a - Transom Harness Connection
b - CAN Line Connection

4. Connect trim position sender connection from gimbal housing to engine harness.

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground studs on engine.

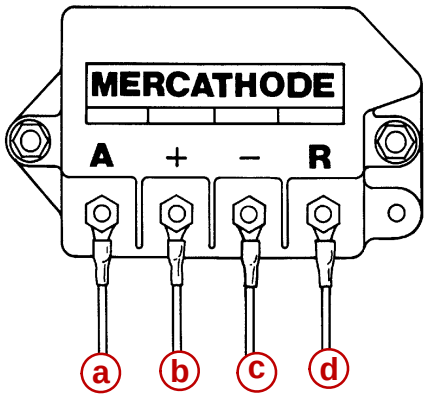
5. Connect continuity wire between transom plate and engine ground (–) stud.



a - Continuity Wire
b - Engine Ground (-) Stud

6. Connect any grounding wires or accessories that may have been disconnected.

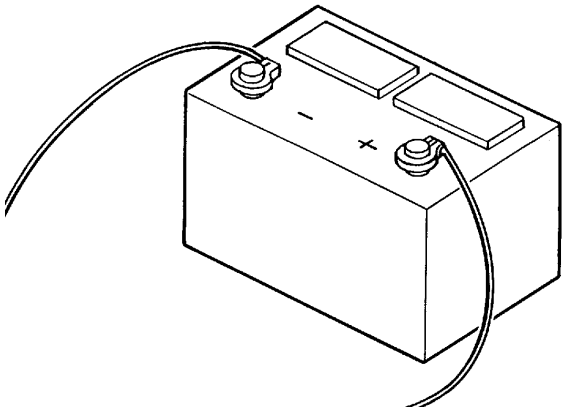
7. Connect wires to MerCathode controller assembly as shown. Apply a thin coat of Quicksilver Liquid Neoprene to all connections.



22232

a - ORANGE Wire - From Electrode On Transom Assembly
b - RED/PURPLE Wire - To Positive (+) Battery Terminal
c - BLACK Wire - From Engine Harness
d - BROWN Wire - From Electrode on Transom Assembly

8. Connect battery cables to battery by FIRST connecting positive (+) battery cable (usually RED) to positive (+) battery terminal. Tighten clamp securely. Then, connect negative (–) battery cable (usually BLACK) to negative (–) battery terminal. Tighten clamp securely.



77559

NOTE: *Spray terminals with a battery connection sealant to help retard corrosion.*

Power Steering Connections

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - Maintenance of this manual, or refer to the appropriate Mercury MerCruiser Sterndrive Service Manual.

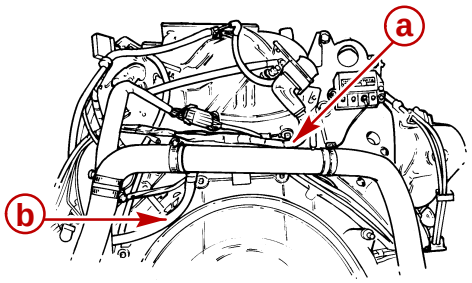
⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leaks.

IMPORTANT: Be careful not to cross-thread or overtighten fittings.

1. Connect both hydraulic hose fittings. Front hose from the cooler. Rear hose from the pump.
2. Torque both fittings to 23 lb-ft (31 Nm).



77596

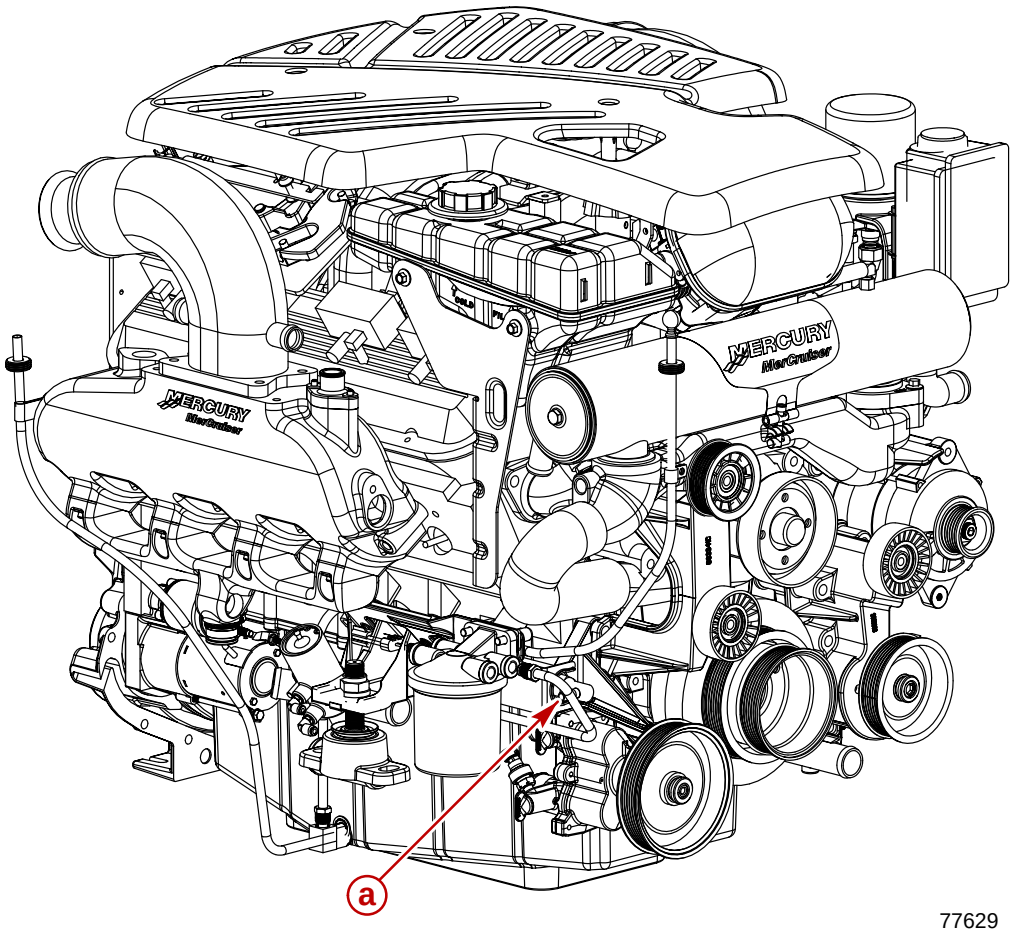
a - Hose From Cooler
b - Hose From Pump

Fuel Supply Connections

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

1. Connect fuel line from fuel tank to boost pump. Ensure connections are secure. Check for leaks.



77629

a - Fuel Inlet Hose Connection

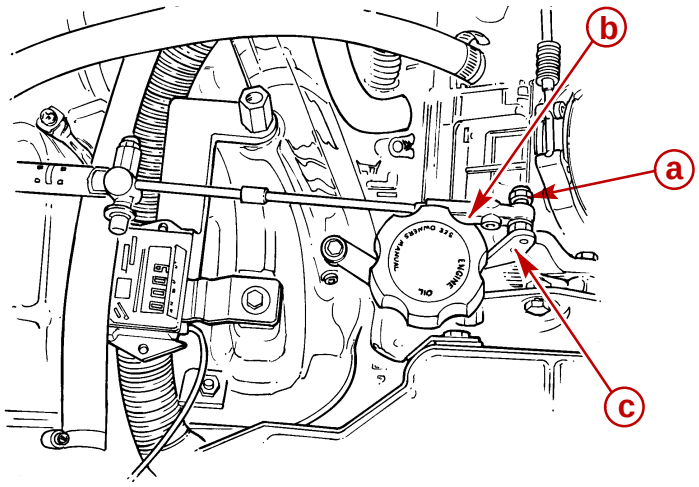
INDEX

Throttle Cable Installation and Adjustment

1. Place remote control handle in NEUTRAL idle position.
2. Remove engine cover.

IMPORTANT: Ensure that cable is routed to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

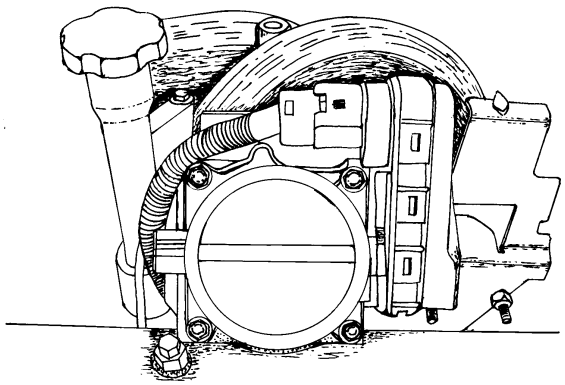
3. Remove flame arrestor.
4. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with hole in anchor plate. Ensure that hole in barrel positions cable as shown.
5. Secure throttle cable with fasteners and tighten securely.



77597

a - Washer and Locknut
b - Cable Barrel
c - Anchor Plate

6. Place remote control throttle lever in the WOT position. Ensure that throttle plate is completely open.



77641

Throttle Plate Open

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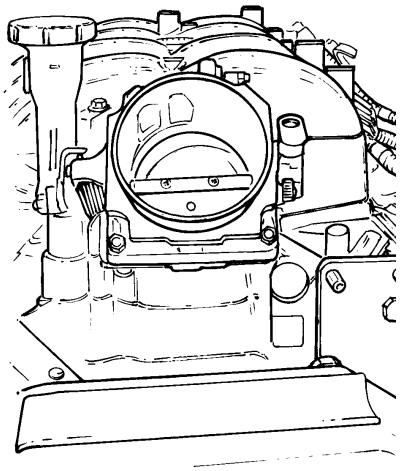
7. Return remote control throttle lever to idle position and ensure that throttle plate is completely closed.



77057

Throttle Plate Closed

8. Reinstall flame arrestor and tighten clamp securely.

IMPORTANT: Adjust shift cables as outlined in appropriate Mercury MerCruiser Sterndrive Service Manual.

9. Refer to appropriate Mercury MerCruiser Sterndrive Service Manual and install and adjust drive unit and remote control shift cables, using hardware retained.

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REMOVAL AND INSTALLATION

Section 2B - MIE Models

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Torque Specifications

Description		lb-in.	lb-ft	Nm
Battery Cables		Securely		
Engine Mount Pads				
Hose Clamps				
Mount Locking Nut [2]				
Propeller Shaft Coupler To Transmission Output Flange			50	68
Trunnion Clamping Bolt / Nut				
Remote Control Shift Cable	Cable Barrel	Securely		
	Cable End Guide	NOTE 1		
Remote Control Throttle Cable	Cable Barrel	Securely		
	Cable End Guide	NOTE 1		

NOTE: *[1] Tighten, then loosen nut 1/2 turn.*

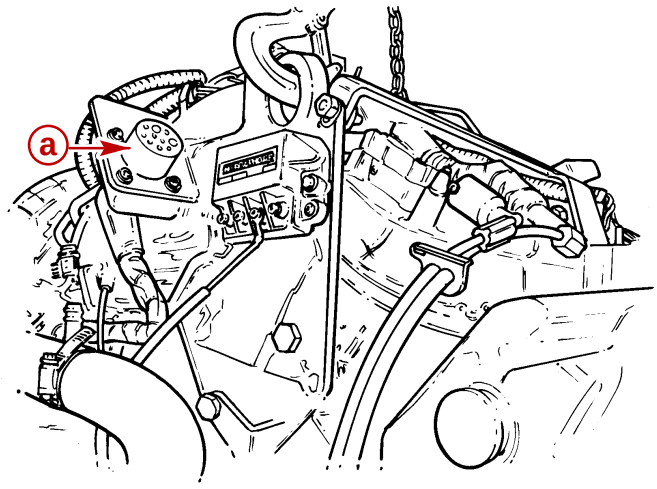
NOTE: *[2] Bend tab against adjusting nut.*

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver 2-4-C Marine Lubricant	92-825407A3
Quicksilver Liquid Neoprene	92-25711--3

Removal

1. Disconnect battery cables from battery.
2. Remove engine cover.
3. Loosen clamp and remove instrument wiring harness plug from engine wiring harness receptacle.



76938

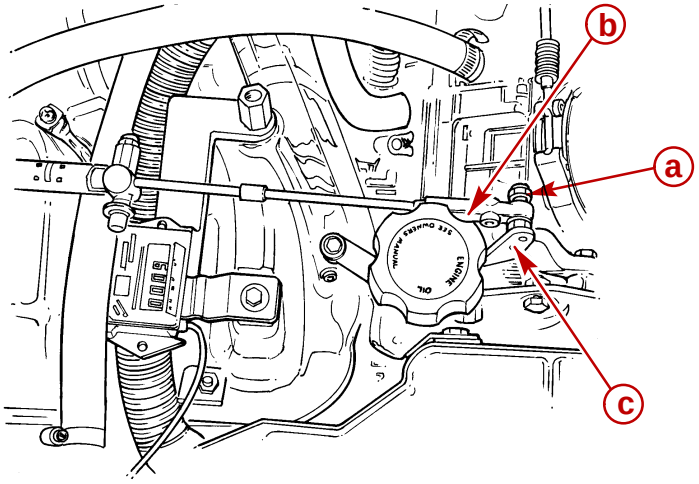
a - Engine Wiring Harness Receptacle

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

4. Loosen hose clamp retaining fuel line to fuel inlet.
5. Close fuel shut off, if equipped. Disconnect and plug fuel line to prevent fuel in line from leaking into bilge.

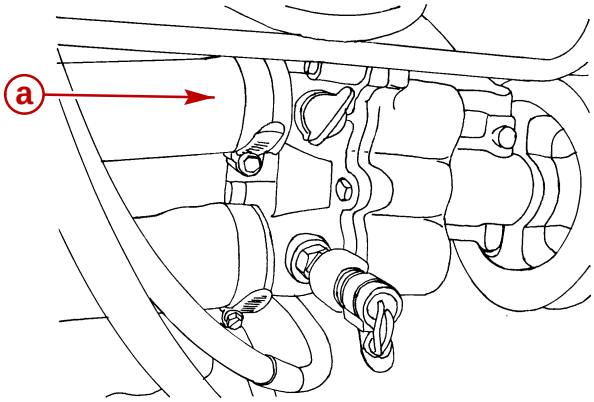
6. Disconnect throttle cable and retain fasteners.



77597

a - Washer and Locknut
b - Cable Barrel
c - Anchor Plate

7. Disconnect shift cable from transmission.
8. Disconnect seawater inlet hose from engine.



77512

a - Seawater Inlet Hose

9. Disconnect exhaust system hoses.
10. Disconnect any grounding wires and accessories that are connected to engine.
11. Disconnect propeller shaft coupler from transmission output flange.

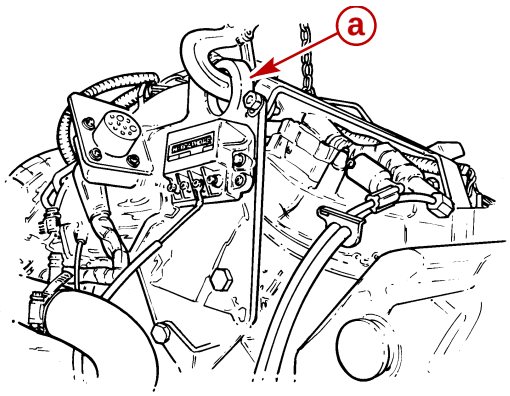
⚠ CAUTION

Engine MUST be lifted with a lifting arm or damage to engine components will occur. DO NOT allow lifting sling to hook or compress engine components or damage will occur.

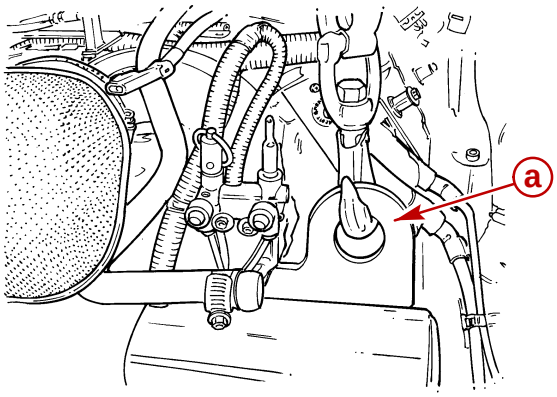
⚠ CAUTION

Engine compartment size may require the removal of additional components.

12. Support engine with suitable sling through lifting eyes on engine.



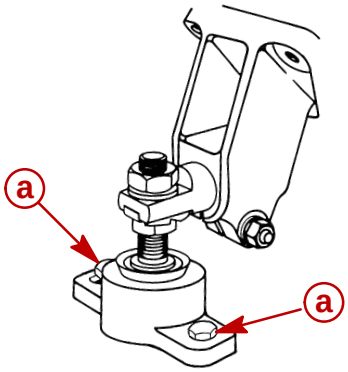
76938



77516

a - Engine Lifting Eyes

13. Remove front and rear engine mounting bolts. Retain fasteners.



72638

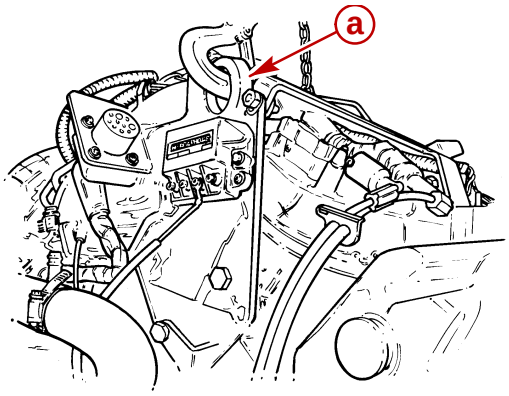
a - Lag Bolt (With Washers)

14. Carefully remove engine.

Initial Engine Alignment

MODELS WITH 8° DOWN ANGLE TRANSMISSIONS

1. Lift engine into boat and position on engine bed so that transmission output flange and propeller shaft coupler are visibly aligned (no gap can be seen between coupling faces when butted together). **Adjust engine bed height** if necessary to obtain proper alignment. DO NOT use mount adjustments to adjust engine position at this time.



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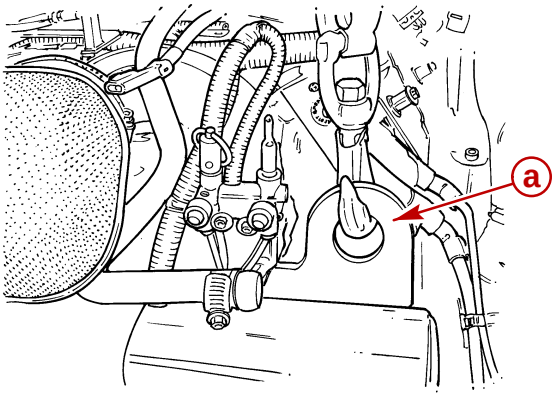
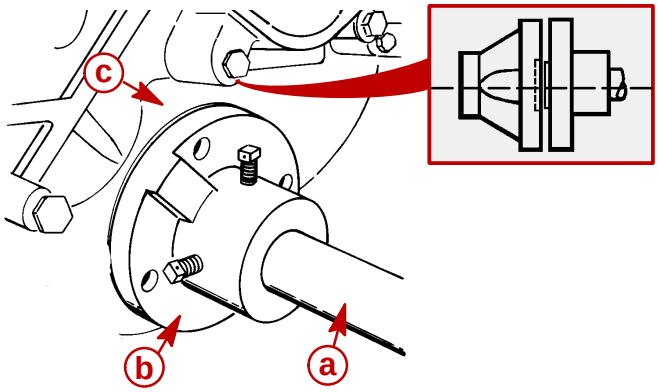


77516

a - Engine Lifting Eyes

IMPORTANT: Engine bed must position engine so that a minimum of 1/4 in. (6 mm) up and down adjustment still exists on all 4 mounts after performing initial alignment. This is necessary to allow for final engine alignment.



74546

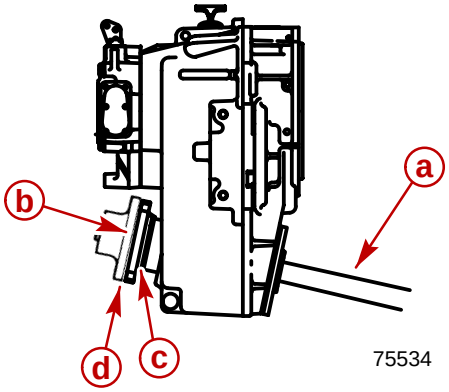
a - Propeller Shaft
b - Propeller Shaft Coupler
c - Transmission Output Flange

2. Ensure that all 4 mounts are still positioned properly, then fasten mounts to engine bed with 3/8 in. (10 mm) diameter lag bolts (of sufficient length) and flat washers. Tighten lag bolts securely.
3. Disconnect overhead hoist and remove sling.

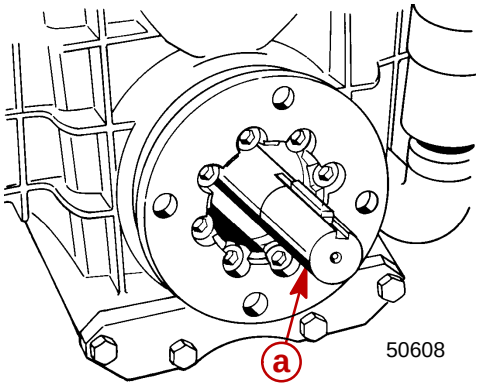
MODELS WITH V-DRIVE TRANSMISSIONS

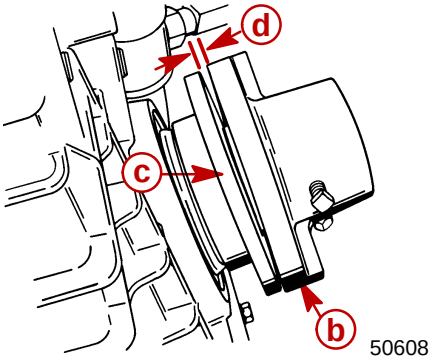
1. Lift engine into boat and position so that enough propeller shaft protrudes through transmission and output flange for propeller shaft coupler to be attached. Then install coupler and position engine (no gap can be seen between coupling faces when butted together). **Adjust engine bed height** if necessary to obtain proper alignment. DO NOT use mount adjustments to adjust engine position at this time.

IMPORTANT: Engine bed must position engine so that a minimum of 1/4 in. (6 mm) up and down adjustment still exists on all 4 mounts after performing final alignment. This is necessary to allow for final engine alignment.



Velvet Drive





Hurth 630V

a - Propeller Shaft
b - Propeller Shaft Coupler
c - Transmission Output Flange
d - **No Gap Allowed**

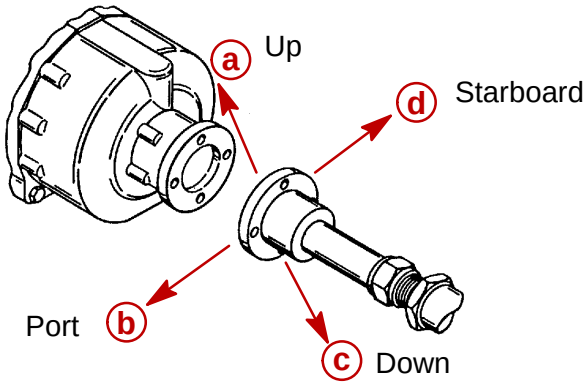
2. Ensure that all 4 mounts are still positioned properly. Fasten mounts to engine bed with 3/8 in. (10 mm) diameter lag bolts (of sufficient length) and flat washers. Tighten lag bolts securely.
3. Disconnect overhead hoist and remove sling.

Final Engine Alignment

IMPORTANT: Engine alignment MUST BE RECHECKED with boat in the water, fuel tanks filled and with a normal load on board.

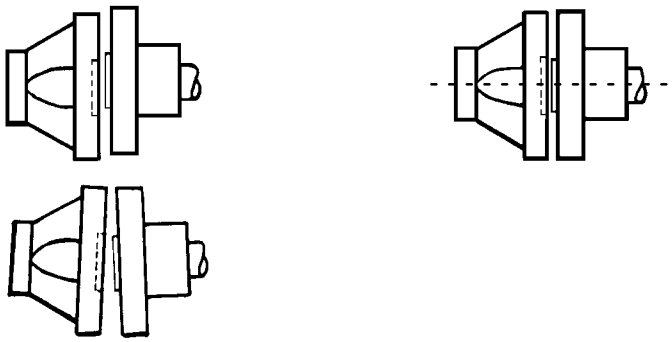
Engine must be aligned so that transmission and propeller shaft coupling centerlines are aligned and coupling faces are parallel within .003 in. (0.07 mm). This applies to installations with solid couplings as well as flexible couplings.

1. Check mating faces on transmission output flange and propeller shaft coupler to make sure they are clean and flat.
2. Center propeller shaft in shaft log as follows:
   a. Push down and then lift shaft as far as it will move. Then place shaft in the middle of the movement.
   b. Move shaft to port and then to starboard as far as shaft will move. Then place shaft in the middle of the movement.
   c. With shaft in the center of shaft log as determined by above procedures “a.” and “b.” align engine to shaft.



Typical Down Angle (V-Drive Similar)

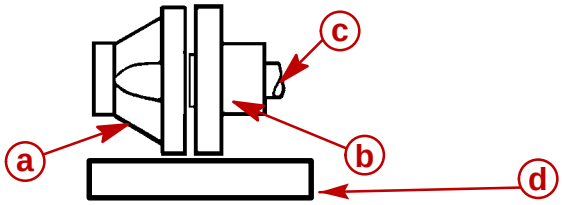
3. Check that coupling centerlines align by butting propeller shaft coupler against transmission output flange. Shoulder on propeller shaft coupler face should engage recess on transmission output flange face with no resistance.



72597

Incorrect **Correct**

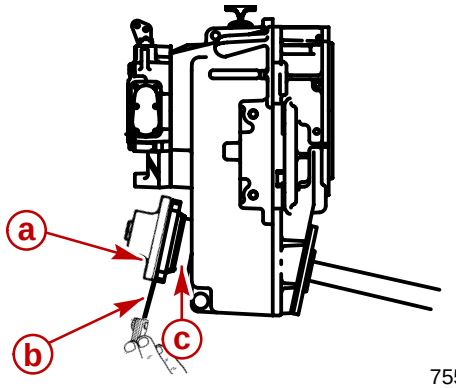
NOTE: *Some propeller shaft couplers may not have a shoulder on mating face. On these installations, use a straight edge to check centerline alignment.*



74483

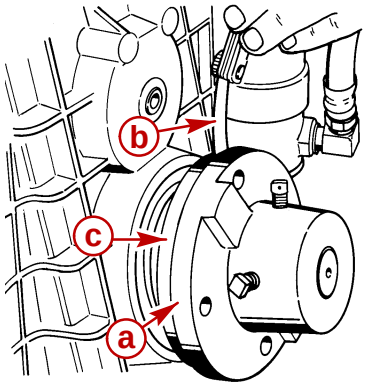
a - Transmission Output Flange
b - Propeller Shaft Coupler
c - Propeller Shaft
d - Straight Edge

4. Check for angular misalignment by hand holding coupling faces tightly together and checking for a gap between coupling faces with a .003 in. (0.07 mm) feeler gauge at 90° intervals.

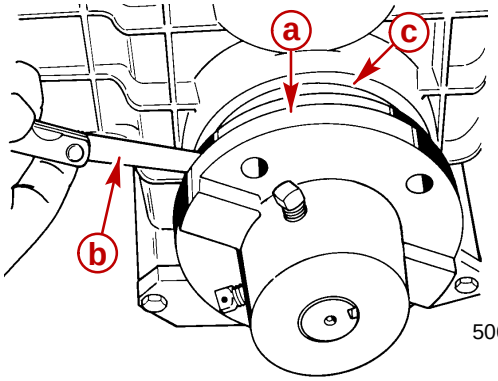


75534

Velvet Drive



50609



50608

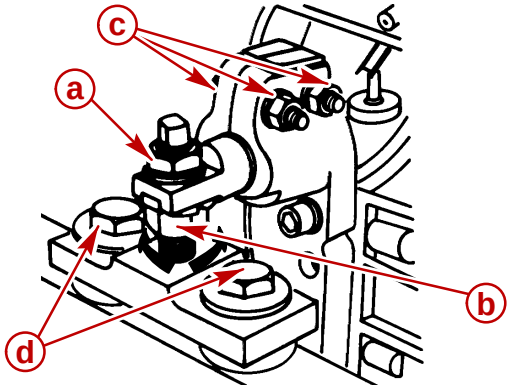
Hurth

a - Propeller Shaft Coupler
b - Feeler Gauge
c - Transmission Output Flange

5. If coupling centerlines are not aligned or if coupling faces are more than .003 in. (0.07 mm) out of parallel, adjust engine mounts.

   a. TO ADJUST ENGINE UP OR DOWN: Loosen locking nut on mounts requiring adjustment and turn adjusting nuts in desired direction to raise or lower.

IMPORTANT: Both front mounts (or rear mounts) adjusting nuts must be turned equally to keep engine level from side to side.



70056

Typical Mount

a - Locking Nut
b - Adjusting Nut
c - Clamping Bolts And Nuts, With Lockwashers
d - Lag Bolts

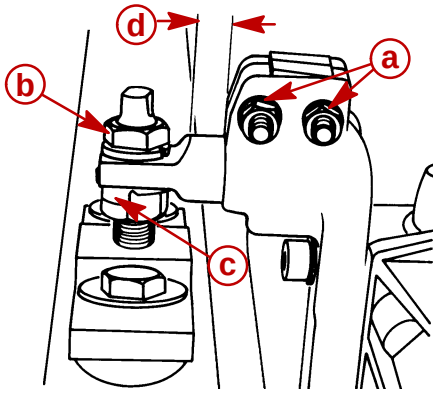
NOTE: *Some rear mounts have one (1) clamping bolt and nut on each side.*

   b. TO MOVE ENGINE TO THE LEFT OR RIGHT: Loosen clamping bolts and nuts on all 4 mount brackets and move engine to the left or right as necessary to obtain proper alignment. Loosen lag bolts (which fasten mounts to engine bed) and move engine, as required. Retighten lag bolts securely.

IMPORTANT: Large diameter of mount trunnion MUST NOT extend over 1 3/4 in. (45 mm) from mount brackets on any of the mounts.

6. After engine has been properly aligned, secure engine mounts.
7. Torque clamping bolts and nuts on all 4 mount brackets to 50 lb-ft (68 Nm).
8. Tighten locknut on all four mounts.

9. Bend one of the tabs on the tab washer down onto the flat of the adjusting nut.



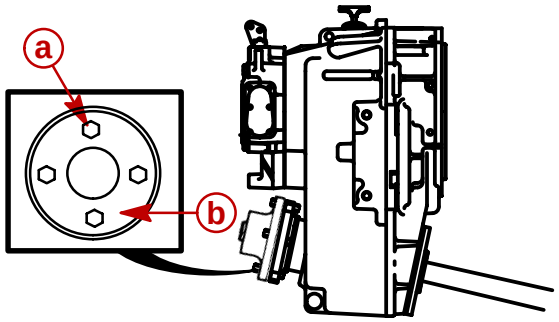
70057

a - Clamping Bolts And Nuts
b - Locknuts On All 4 Mounts
c - Tab On Tab Washer
d - Measurement - 1-3/4 in. (45 mm)

NOTE: *Some rear mounts have one (1) clamping bolt and nut on each side.*

IMPORTANT: All coupler bolts must be SAE Grade 8 (Metric Grade 10.9) or better, with a shoulder (grip length) sufficient to pass through the mating face plane of the couplers.

10. Connect propeller shaft coupler to transmission output flange with bolts, lockwashers and nuts. Torque to 50 lb-ft (68 Nm).



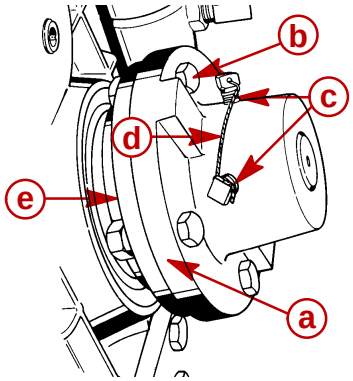
75535

a - Bolts
b - Transmission Coupler

a. If propeller shaft coupler has set screws, remove set screws and mark dimple locations using a transfer punch.

b. To drill dimples, remove propeller shaft coupler and drill shallow dimples at locations marked with punch.

c. Reinstall propeller shaft coupler and torque bolts to 50 lb-ft (68 Nm). Install set screws and safety wire after tightening securely.



50608

Velvet Drive V-Drive Shown (Others Similar)

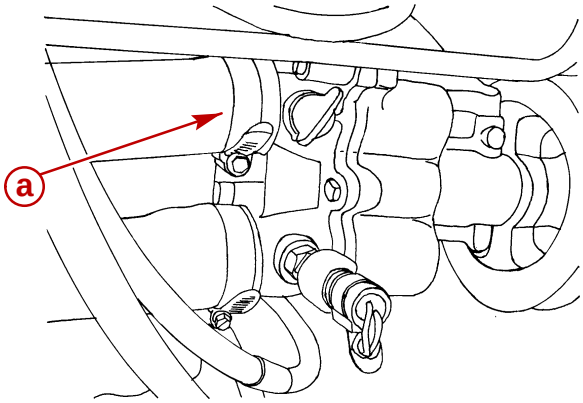
a - Propeller Shaft Coupler
b - Bolts
c - Set Screws
d - Safety Wire
e - Transmission Output Flange

Engine Connections

Seawater Hose Connection

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater inlet hose to seawater pump as shown. Tighten hose clamp securely.

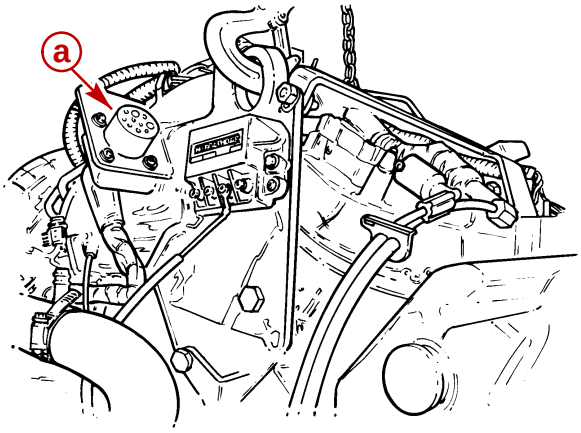


77512

a - Seawater Inlet Hose

Electrical Connections

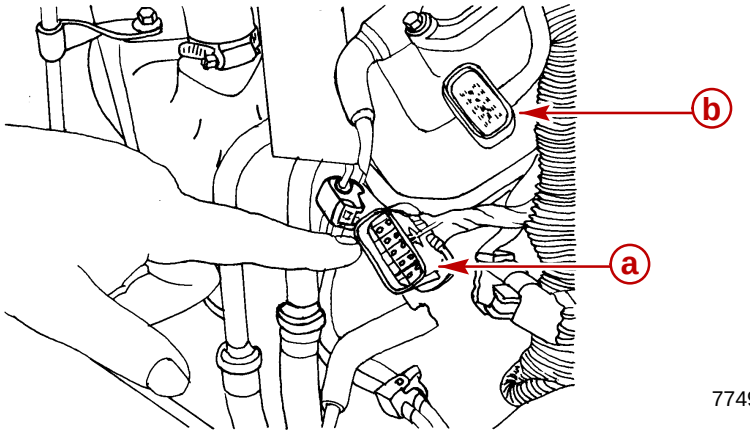
1. Connect instrument wiring harness plug to engine wiring harness receptacle with hose clamp. Tighten clamp securely.



76938

a - Engine Wiring Harness Receptacle

2. Connect CAN line.



77499

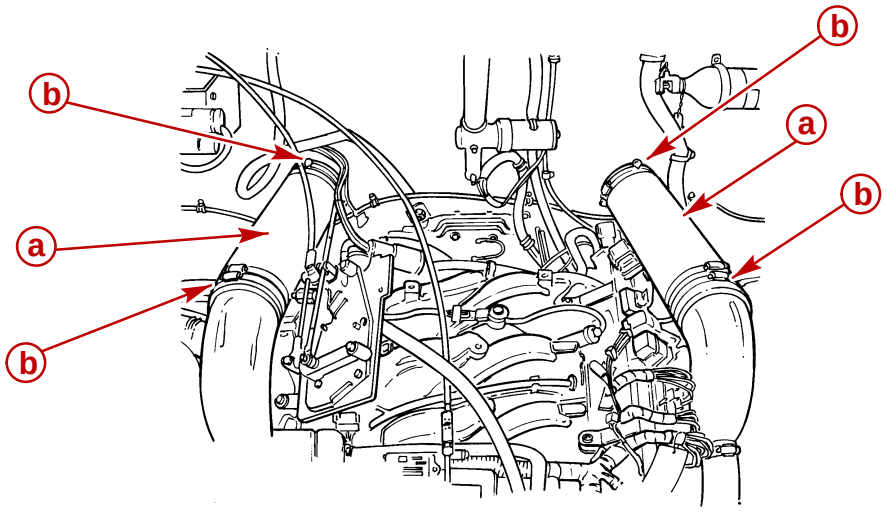
a - Transom Harness Connection (MCM Only)
b - CAN Line Connection

Exhaust Hose Connection

⚠ CAUTION

Avoid exhaust hose failure. Discharge water from exhaust elbow must flow around entire inside diameter of hose to avoid causing hot spots which could eventually result in burned-through exhaust hoses. Exhaust hoses and/or tubes must be correctly connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow.

1. Connect exhaust system tubes and hoses using at least two hose clamps at each connection. Tighten hose clamps securely.



77593

a - Exhaust Tubes
b - Clamps

Fuel Supply Connections

Refer to **SECTION 2A.**

Throttle Cable Installation and Adjustment

Refer to **SECTION 2A.**

Shift Cable Installation And Adjustment

Refer to **SECTION 8A and 8B**

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ENGINE

Section 3A - 496 CID (8.1L)

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Torque Specifications

Description	lb-in.	lb-ft	Nm
Camshaft Position Sensor Bolt	106		12
Camshaft Retainer Bolt	106		12
Camshaft Sprocket Bolt		22	30
Connecting Rod Bolt Nut			
First Pass		22	30
Final Pass		90°	
Coolant Drain Hole Plug			
Left Front		44	60
Sides		15	20
Crankshaft Bearing Cap Bolt			
First Pass		22	30
Final Pass		90°	
Crankshaft Bearing Cap Stud			
First Pass		22	30
Final Pass		80°	
Crankshaft Balancer Bolt / Torsional Damper Bolt		189	255
Crankshaft Oil Deflector Nut		37	50
Crankshaft Position Sensor Bolt	106		12
Cylinder Head Bolt (In Sequence)			
First Pass		22	30
Second Pass		22+120°	30+120°
Final Pass-Long and Medium Bolts #1,2,3,6,7,8,9,10,11,14, 15,16,17,18		60°	
Final Pass–Short Bolts #4,5,12,13		30°	
Exhaust Manifold Cap Screws		26	35
Flywheel Bolt		74	100
Flywheel Housing		30	41

Description	lb-in.	lb-ft	Nm
Front Cover Bolt	106		12
Fuel Rail			
Nut	71		8
Stud or Cap Screw	89		10
Ignition Coil Bolt	106		12
Ignition Coil Wiring Harness Bolt	106		12
Intake Manifold Bolt (In Sequence)	106		12
Knock Sensor		*	*
Lifter Restrictor Retainer		19	25
MAP Sensor Bolt	106		12
Oil Gallery Plug			
Front		22	30
Left		22	30
Rear		22	30
Top		15	20
Oil Pan Bolt		19	25
Oil Pan Drain Plug		21	28
Oil Pump Bolt		56	75
Oil Pump Cover Bolt	106		12
Oil Pump Drive Bolt		19	25
Rocker Arm Nuts		19	25
Rocker Arm Cover Bolt	106		12
Rocker Arm Stud		37	50
Spark Plug		22	30
Thermostat Retainer		12	16
Throttle Body			
Nut	88		10
Stud	106		12
Transmission to Flywheel Housing		50	68
Water Pump Bolt		37	50
Water Pump Pulley Bolt		19	25

Tools

Special Tools

Description	Part Number
Pressure Gauge (0-500 psi)	Obtain Locally
Valve Spring Compressor	J-8062
Carbon Remover Brush	J-8358
Valve Spring Tester	J-9666
Valve Spring Compressor	S6121
Air Line Adaptor Tool	J-23590
Camshaft Bearing Remover And Installer Set	J-33049
Torsional Damper Remover and Installer	J-23523-E
Crankshaft Gear Puller	J-42846
Ball Socket Adapter Tool	J-8520-1
Valve Lifter Removal Tool	J3049-A
Piston Ring Expander	91-24697
Piston Ring Compressor	J-8037
Dial Indicator	J-7872
Pulley Tool	J–41240
Front Cover Seal Installer	J-22102
Rear Main Seal Installer	J-38841

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Loctite 27131	92-809820
Quicksilver Perfect Seal	92-34227--1
Quicksilver RTV Sealer / Loctite 587	92-809826
General Motors Cam and Lifter Prelube or Equivalent	Obtain Locally

Engine Specifications

496 CID (8.1L) Engine Specifications

Model	496 MAG / 8.1S Horizon	496 MAG HO / 8.1S HO
Displacement	496 cid (8.1L)	
Bore	4.25 (108)	
Stroke	4.38 (111)	
Compression Ratio	9.1:1	
Heads	Cast Iron	
Intake Manifold	Aluminum	
Block	Cast Iron (4 Bolt Main Bearing Caps)	
Rods	Forged Steel	
Pistons	Cast Aluminum	
Crankshaft	Casted Steel	Forged Steel
Camshaft	Steel	
Engine Compartment Pressure Differential	2 in H_2O (0.5 kPa)	
Engine Compartment Temperature	Maximum 176° (80° C)	

CYLINDER BORE

Model			496 CID / 8.1 L
Diameter			4.250 - 4.2507 in. (107.95 - 107.968 mm)
Out of Round		Production	.0010 in. (.025 mm)
		Service	*
Taper	Production	Thrust Side	.0005 in. (.013 mm)
		Relief Side	.0010 in. (.025 mm)
	Service		*

* Not available at time of printing.

496 CID (8.1L) Engine Specifications (Continued)

PISTON

Model		496 CID / 8.1 L
Clearance	Production	*
	Service	*

PISTON PIN

Model		496 CID / 8.1 L
Diameter		1.04 - 1.0401 in. (26.416 - 26.419 mm)
Clearance In Pin	Production	.00039 - .00066 in. (.010 - .017 mm)
	Service	*
Fit In Rod		.00019 - .0007 in. (.049 - .020 mm)

PISTON RING

Model				496 CID / 8.1 L
Compression	Groove Side Clearance	Production	Top	.0012 - .0029 in. (.031 - .074 mm)
			2nd	.0012 - .0029 in. (.031 - .074 mm)
		Service		*
	Gap	Production	Top	.0098 - .0161 in. (.249 - .409 mm)
			2nd	.0177 - .0256 in. (.450 - .650 mm)
		Service		*
Oil	Groove Side Clearance	Production		*
		Service		*
	Gap	Production		.0098 - .0099 in. (.249 - .759 mm)
		Service		*

* Not available at time of printing.

496 CID (8.1L) Engine Specifications (Continued)

CRANKSHAFT

Model			496 CID / 8.1 L
Main Journal	Diameter	No.1,2,3,4,5	2.7482 - 2.7489 in. (69.804 - 69.822 mm)
	Taper	Production	.0004 in. (.0102 mm) (max)
		Service	*
	Out of Round	Production	.0004 in. (.0102 mm) (max)
		Service	*
Main Bearing Clearance	Production	No.1,2,3,4	.0011 - .0024 in. (.028 - .061 mm)
		No.5	.0025 - .0038 in. (.064 - .097 mm)
	Service	No.1	*
		No.2,3,4	*
		No.5	*
Crankshaft End Play			.0050 - .0110 in. (.127 - .279 mm)
Connecting Rod Journal	Diameter		*
	Taper	Production	.0004 in. (.0102 mm)
		Service	*
	Out of Round	Production	.0004 in. (.0102 mm)
		Service	*
Rod Bearing Clearance		Production	.0011 - .0029 in. (.0279 - .0736 mm)
		Service	*
Rod Side Clearance			.0151 - .0270 in. (.384 - .686 mm)
Crankshaft Runout @ No.3 Main Bearing			*

* Not available at time of printing.

496 CID (8.1L) Engine Specifications (Continued)

VALVE SYSTEM

Model			496 CID / 8.1 L
Lifter			Hydraulic, Roller Followers
Rocker Arm Ratio			1.70:1
Face Angle (Intake & Exhaust)			45
Seat Angle (Intake & Exhaust)			46
Seat Runout (Intake & Exhaust)			.002 in. (.050 mm) (max)
Seat Width		Intake	.03-.06 in. (.800-1.200 mm)
		Exhaust	.06 - .095 in. (1.651 - 2.159 mm)
Stem Clearance	Production	Intake	.001 - .0029 in. (.025 - .074 mm)
		Exhaust	.0012 - .0031 in. (.030 - .079 mm)
	Service	Intake	*
		Exhaust	*
Stem Diameter		Intake	.3715 - .3722 in. (9.436 - 9.454 mm)
		Exhaust	.3713 - .3720 in. (9.431 - 9.449 mm)
Valve Margin (Intake and Exhaust)			*
Valve Lash (Intake and Exhaust)			*

VALVE SPRING

Model			496 CID / 8.1 L
Valve Spring [1]	Free Length		2.1929 in. (55.70 mm)
	Pressure	Closed at 1.838 in. (46.680 mm)	58 - 64 lb (267 - 293 N)
		Open at 1.34 in. (33.980 mm)	189 - 207 lb (840 - 920 N)
	Installed Height		1.838 - 1.869 in. (46.680 - 47.479 mm)
Damper or Damper Shield	Free Length		*
	Approximate Number Of Coils		*
Damper or Damper Shield	Valve Spring Fit in Damper Shield		*

* Not available at time of printing.

496 CID (8.1L) Engine Specifications (Continued)

ROLLER TAPPET CAMSHAFT

Model		496 Mag / 8.1S Horizon	496 Mag HO / 8.1S HO
Lobe Lift	Exhaust	.284 in. (7.22 mm)	.30 in. (7.62 mm)
	Intake	.282 in. (7.16 mm)	.30 in. (7.62 mm)
Duration at .050 In.(1.27mm) Cam Lift	Exhaust	*	*
	Intake	*	*
Journal Diameter		1.9477 - 1.9479 in. (49.472 - 49.522 mm)	
Journal Out Of Round		*	*
Camshaft Runout		.002 in. (.051 mm) (max)	
Timing Chain Deflection		.375 in. (9.5 mm) from taut position. Total .75 in. (19 mm)	

CYLINDER HEAD

Model	496 Mag
Gasket Surface Flatness	.004 (0.1016 mm) overall max .003 in. (.076 mm) with 6 in (152 mm) Span

* Not available at time of printing.

General Information

Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

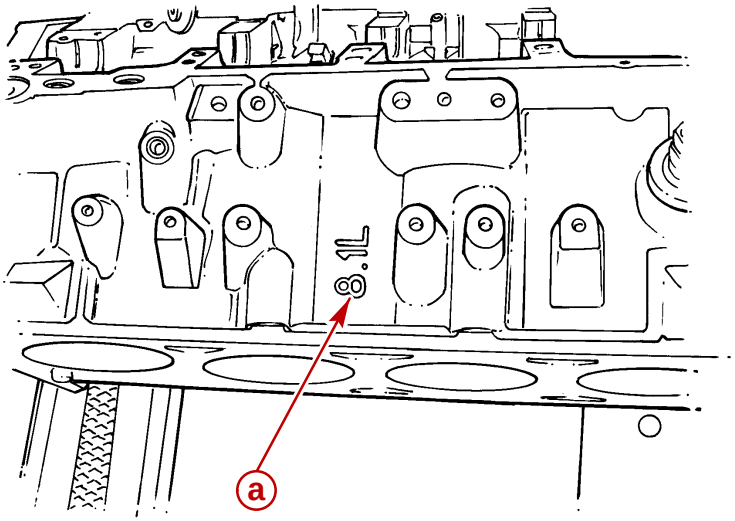
When engine removal is not required, make certain that battery cables are disconnected at the battery prior to performing any on-board repair procedures.

Lubricate all moving parts (during reassembly) with engine oil or assembly lube. Apply Quicksilver Perfect Seal on threads of and under heads of cylinder head bolts and on threads of all cylinder block external bolts, screws and studs.

Special Notice

This section is primarily concerned with repairs to the block. Some external components that are not mentioned in the procedural steps must be removed for ease of repair . Refer to appropriate sections of this manual for concerns regarding the removal and installation of any component hindering repairs made to the block.

Engine Identification



77479

a - 8.1L Identification On Port Side Of Engine Block

Cylinder Head Identification

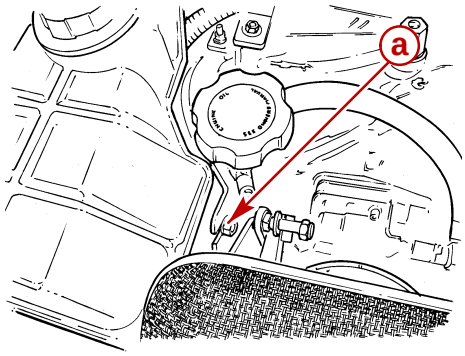
496 CID (8.1L)

Cylinder heads are identified by their large rectangular ports and the absence of water jacket holes.

Rocker Arm Cover

Removal

1. Remove engine cover.
2. Remove wiring harness from top and front of engine.
3. **On Port Side:**
   a. Remove remote oil lines. Some oil is retained in oil filter and remote oil lines.
4. **On Starboard Side:**
   a. Drain coolant from coolant reservoir.
   b. Remove coolant reservoir.



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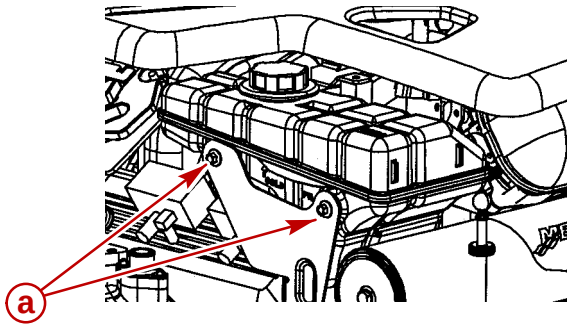
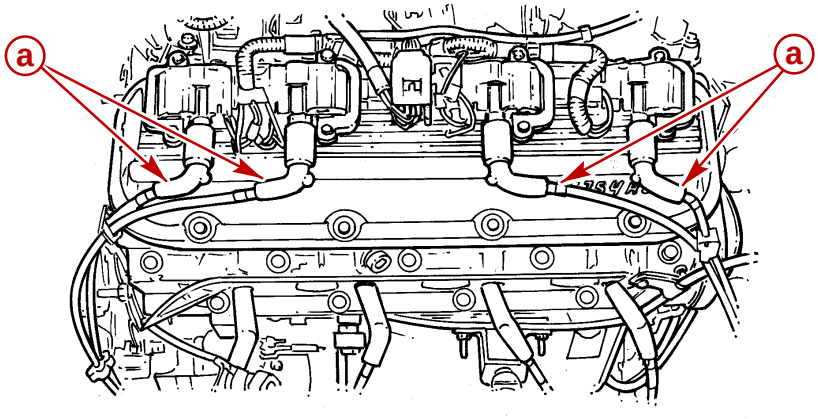


77629

a - Coolant Reservoir Fasteners

5. Remove spark plug wires from coils.



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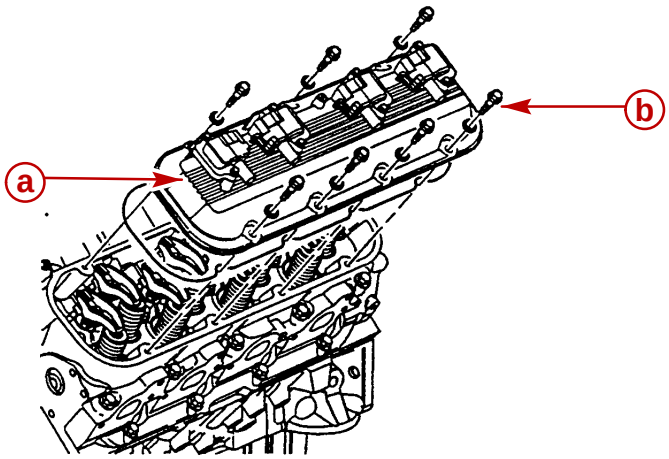
Exhaust Manifold Removed For Clarity

a - Spark Plug Wires

6. Remove exhaust manifold assemblies.
7. Remove screws fastening rocker arm cover to engine.

8. Remove rocker arm cover.

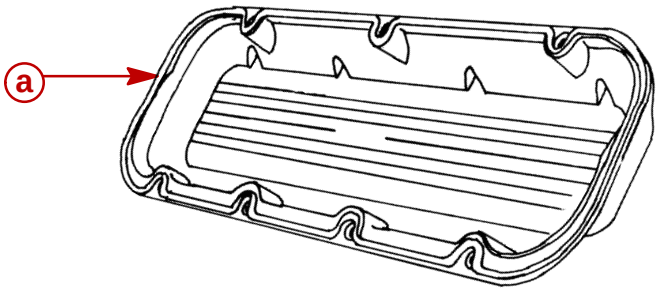


76694

a - Rocker Arm Cover
b - Screws

Installation

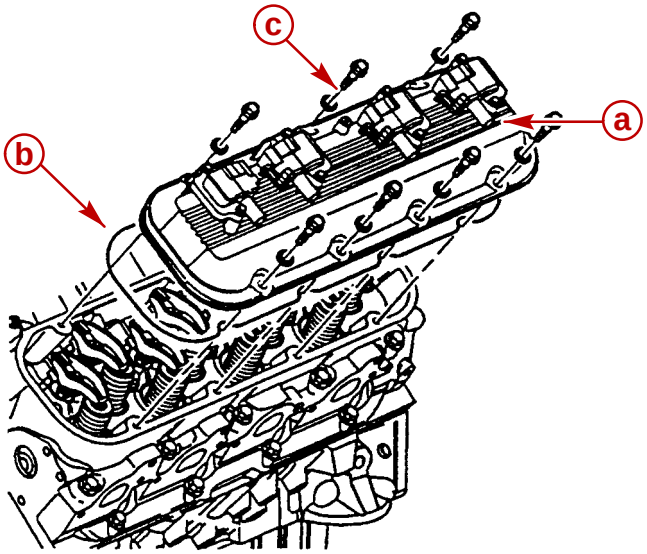
1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Place new rocker arm cover gasket on rocker arm cover.



77423

a - Rocker Arm Cover Gasket

3. Install rocker arm cover. Torque bolts to 106 lb-in. (12 Nm).



76694

a - Rocker Arm Cover
b - Gasket
c - Screws

4. Reinstall exhaust manifolds.
5. **On Port Side:**
   a. Install remote oil lines.
6. **On Starboard Side:**
   a. Install coolant reservoir.
7. Check oil level. Add if necessary.
8. Fill closed cooling system.
9. Connect wiring harness.
10. Start engine and check for oil and coolant leaks.

Intake Manifold

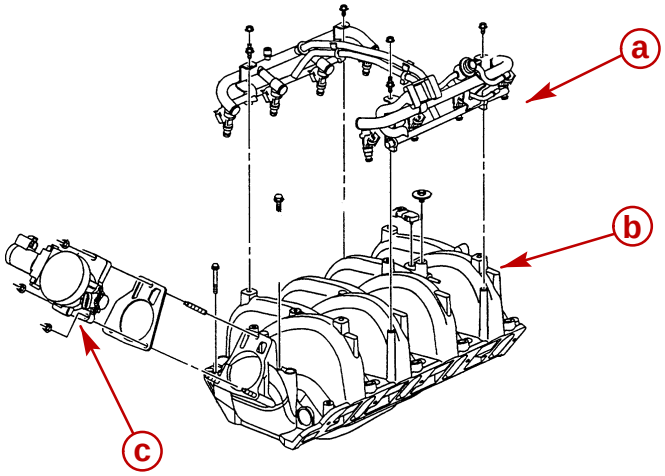
Removal

1. Disconnect wiring harness leads interfering with removal.
2. Remove gear lube monitor.
3. Disconnect throttle cable from throttle body.
4. Remove fuel line.
5. Remove shift plate assembly.
6. Remove ECM bracket.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block in next step. Use extreme care to prevent damage to sealing surfaces.

7. Remove intake manifold bolts.
8. Remove intake manifold and throttle body assembly.

NOTE: *If intake manifold requires replacement, transfer all remaining parts to new manifold.*

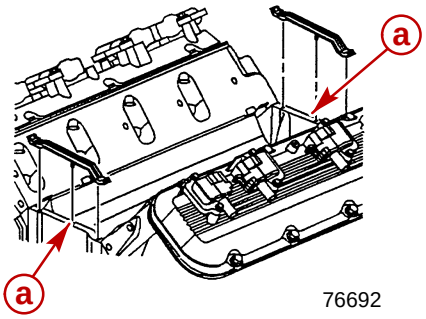


76681

a - Fuel Rail Assembly
b - Intake Manifold
c - Throttle Body

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.



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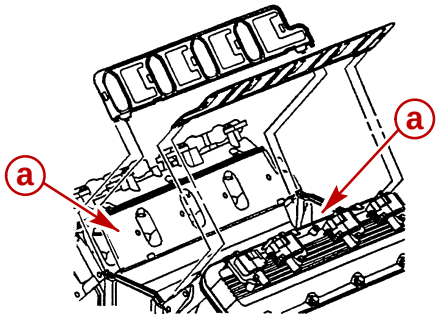


76691

a - Cylinder Head Mating Surfaces

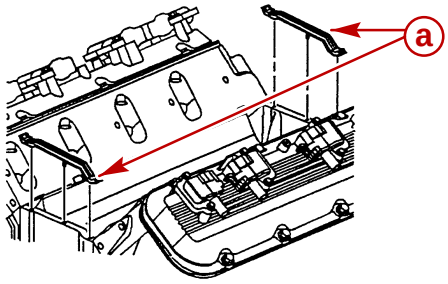
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or intake ports.

2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Check intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

IMPORTANT: When installing intake manifold gaskets ensure marked side is facing up. Both gaskets are identical.

1. Using 3M Brand Adhesive, glue new neoprene gaskets to engine block between cylinder heads.

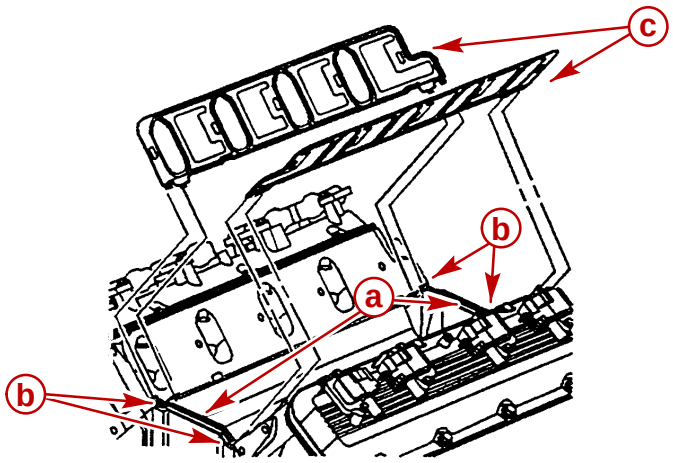


76692

a - Neoprene Gaskets

2. Apply a small amount of RTV Sealer on neoprene gasket ends.

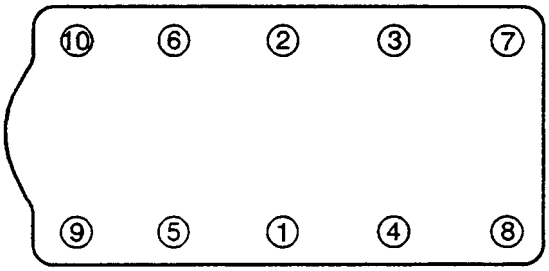
3. Set intake manifold gaskets in place, aligning bolt holes.



76691

a - Neoprene Gaskets
b - RTV Sealer
c - Gaskets

4. Install intake manifold assembly. Torque in sequence to 106 lb-in. (12 Nm).



76797

Intake Manifold Torque Sequence

5. Connect all wiring harness leads.
6. Install fuel line.
7. Reconnect throttle cable.
8. Install shift plate assembly.
9. Install gear lube monitor.
10. Connect throttle cable from throttle body.
11. Install ECM bracket.
12. Start engine.
13. Check hose connections, gaskets and seals for leaks.
14. Inspect fuel line connections for fuel leaks.

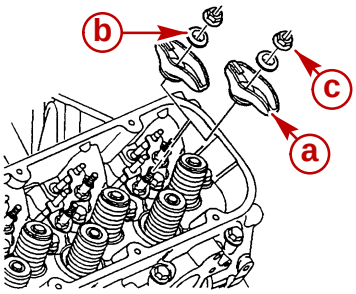
Rocker Arm/Push Rod

Removal

NOTE: *When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing rocker arms. When servicing all rocker arms, bring No. 1 piston up to TDC before removing rocker arms.*

IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

1. Remove rocker arm covers.
2. Remove rocker arm assemblies and push rods.



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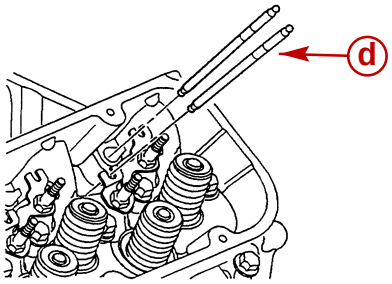
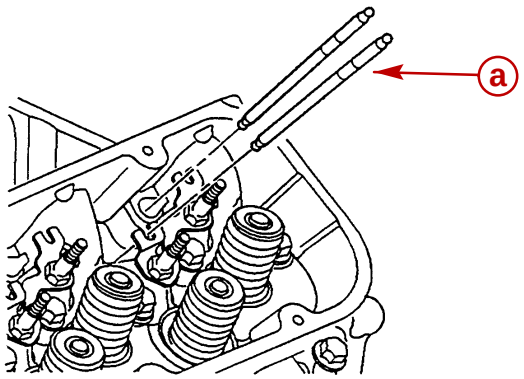


76696

a - Rocker Arms
b - Rocker Arm Balls
c - Nuts
d - Push Rods

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.



76696

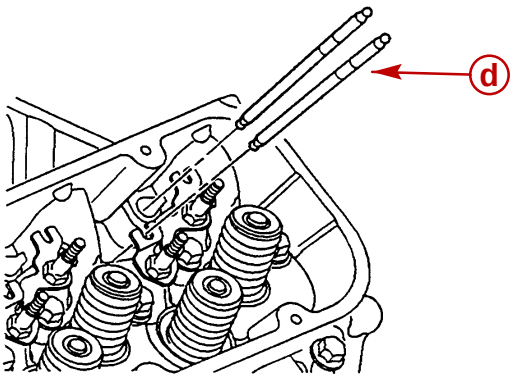
a - Push Rods

2. Inspect all contact surfaces for wear. Replace all damaged parts.

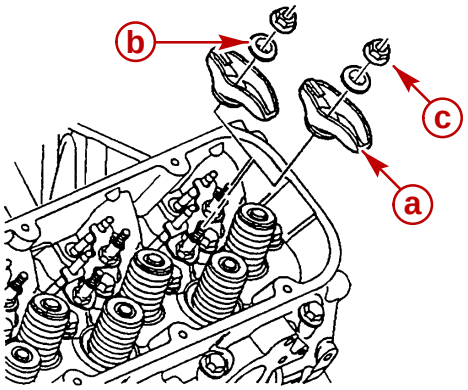
Installation

IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

1. Install push rods in their original locations. Be sure push rods seat in lifter socket.
2. Install rocker arm assemblies in their original locations.



76696



76695

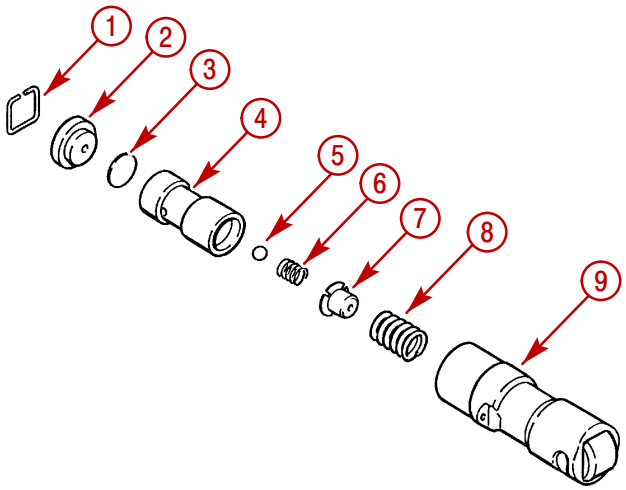
a - Rocker Arms
b - Rocker Arm Balls
c - Nuts
d - Push Rods

3. Ensure cylinder is at TDC and both valves are closed. Torque to 19 lb-ft (25 Nm).

Valve Adjustment

No adjustment is required. Valve lash is automatically set when rocker arm bolts are torqued to 19 lb-ft (25 Nm).

Hydraulic Roller Valve Lifters



72031

1 - Push Rod Seat Retainer
2 - Push Rod Seat
3 - Metering Valve
4 - Plunger
5 - Check Ball
6 - Check Ball Spring
7 - Check Ball Retainer
8 - Plunger Spring
9 - Lifter Body

Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft (1.2 m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

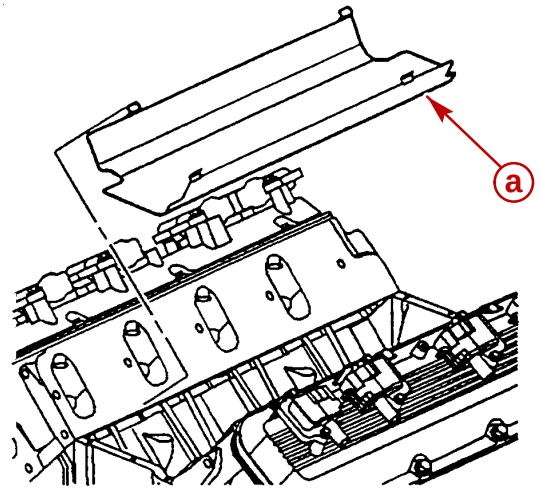
1. Hard rapping noise - usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or “pickup” between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise - probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train - this will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking - probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out of round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it more likely exists in all the units; thus it would only be a matter of time before all lifters caused trouble.

Removal

IMPORTANT: Keep push rod and hydraulic valve lifter from each valve together as a matched set and mark them so they can be reinstalled in the same location.

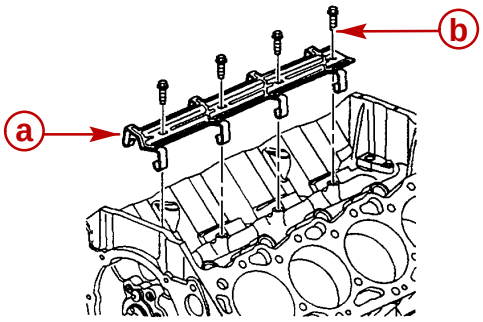
1. Remove rocker arm covers.
2. Remove intake manifold and related components.
3. Remove rocker arm assemblies and push rods.
4. Remove splash shield.



76693

a - Splash Shield

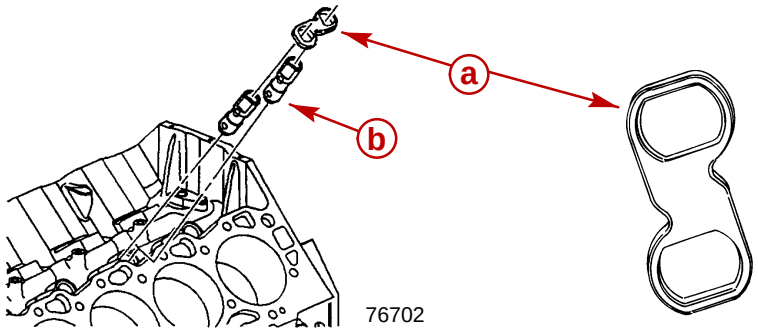
5. Remove lifter restrictor retainer.



76701

a - Lifter Restrictor Retainer
b - Fasteners

6. Remove lifter restrictors.
7. Remove valve lifters.



a - Lifter Restrictor
b - Valve Lifter

Installation

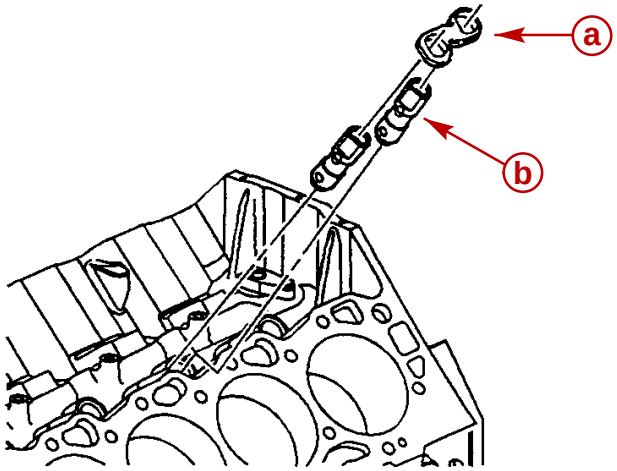
IMPORTANT: It is recommended that the engine oil be changed and a new oil filter be installed whenever servicing valve lifters or camshaft.

IMPORTANT: Before installing lifters, coat the bottom of the lifter with engine oil or assembly lube. If new lifters or a new camshaft have been installed, an additive containing EP lube (such as General Motors Cam and Lifter Pre-lube or equivalent) should be poured over camshaft lobes before installing lifters.

IMPORTANT: Before installation, coat entire valve lifter with engine oil.

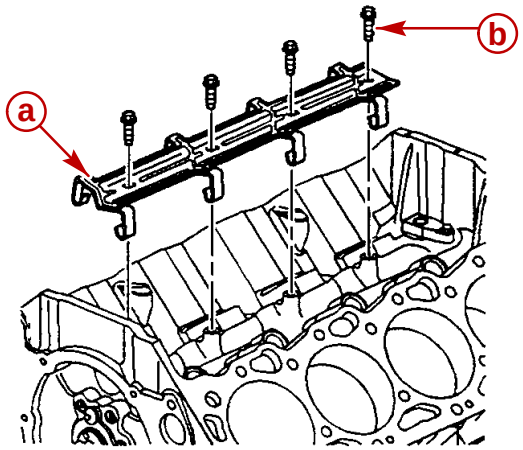
IMPORTANT: Mercury Mercruiser recommends using new valve lifters if installing a new camshaft.

1. Install valve lifters and restrictors.



a - Lifter Restrictor
b - Valve Lifter

2. Install lifter restrictor retainer. Torque to 19 lb-ft (25 Nm).



76701

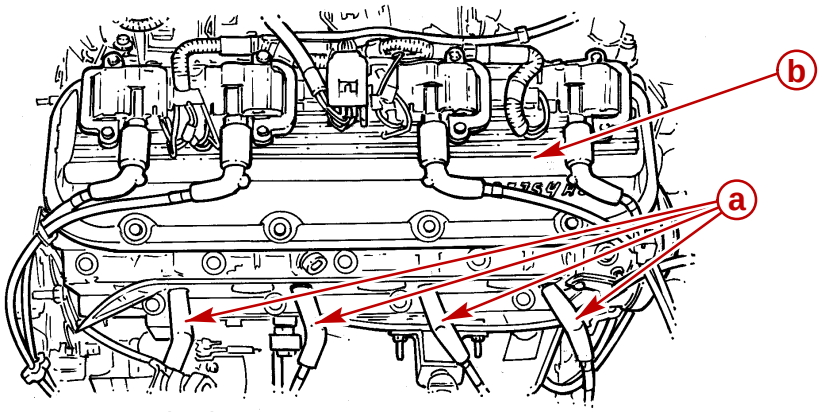
a - Lifter Restrictor Retainer
b - Screws

3. Install splash shield.
4. Install intake manifold and related components.
5. Install push rods and rocker arms.
6. Install rocker arm cover.
7. Start engine and check for leaks.

Valve Stem Oil Seal / Valve Spring

Removal - Head Installed

1. Remove spark plug of affected cylinder.
2. Remove rocker arm cover.

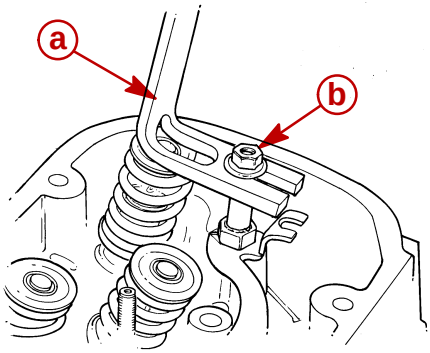


77434

a - Spark Plugs
b - Rocker Arm Cover

3. Remove rocker arm assembly from affected cylinder.
4. Install air line adaptor tool (J-23590) in spark plug hole and apply compressed air to hold valves in place.

5. Using valve spring compressor, compress valve spring and remove valve locks.



77575

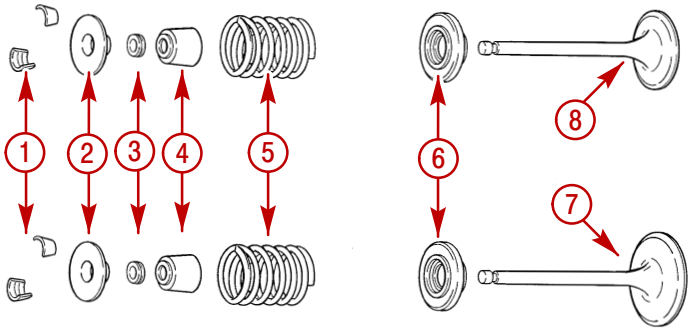
a - Valve Spring Compressor (S6121)
b - Rocker Arm Nut

6. Slowly release valve spring compressor. Remove cap, shield and valve spring.

IMPORTANT: Maintain air pressure in cylinder while springs, caps and valve locks are removed or valves will fall into cylinder.

7. Remove oil shields from valve stems.

Valve Assembly (Exploded View)

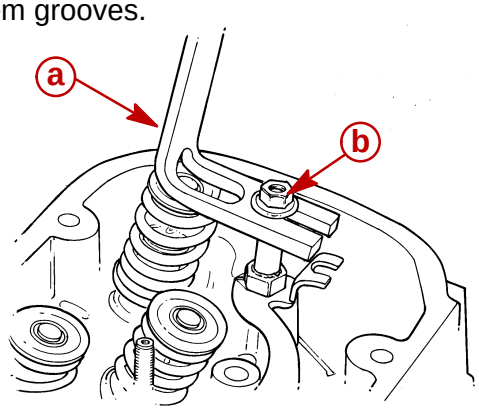


75721

1 - Valve Lock
2 - Retainer
3 - Oil Shield Seal
4 - Oil Shield
5 - Outer Spring
6 - Rotator
7 - Intake Valve
8 - Exhaust Valve

Installation - Head Installed

1. Place rotator or shim on valve spring seat.
2. Coat valve stem and new seal with engine oil. Install seal over valve stem.
3. If taken apart, reassemble damper and valve spring. Place on top of rotator or shim.
4. Set valve spring assembly and cap in position over valve stem.
5. Compress spring, using valve spring compressor, and install valve locks (grease may be used to hold valve locks in place). Slowly release tool and ensure valve locks seat properly in valve stem grooves.



77575

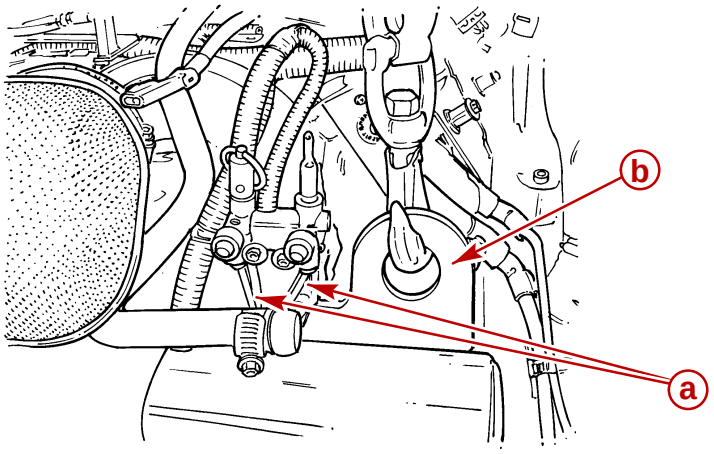
a - Valve Spring Compressor (S6121)
b - Rocker Arm Nut

6. Install push rods and rocker arm assemblies.
7. Install rocker arm cover.
8. Install spark plug and torque to 22 lb-ft (30 Nm).

Cylinder Head

Removal

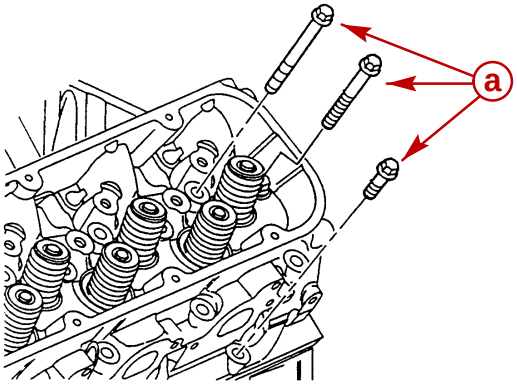
1. Drain closed cooling system.
2. Remove exhaust manifold assembly.
3. Remove heat exchanger.
4. Remove coolant crossover.
5. Remove front and rear lifting eyes.
6. Disconnect air actuated drain system hoses.



77516

a - Air Actuated Drain System Hoses
b - Front Lifting Eye

7. Remove alternator bracket.
8. Remove intake manifold.
9. Remove rocker arm covers.
10. Remove rocker arm assemblies and push rods (keep in order for reassembly in their original locations).
11. Remove head bolts.



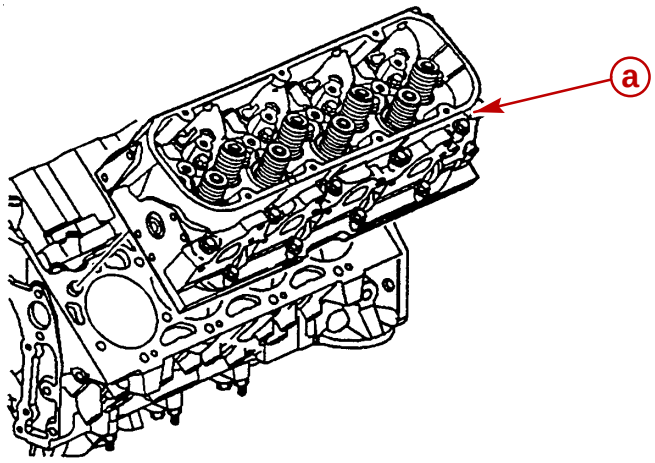
76698

a - Head Bolts

⚠ CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. DO NOT damage gasket surfaces. DO NOT drop cylinder heads.

12. Remove cylinder head and place on wooden blocks to prevent damage to gasket surfaces.



76699

a - Cylinder Head

Cleaning

1. Clean gasket material and sealer from engine block and cylinder heads.
2. Clean engine block bolt hole threads, ensuring no dirt, old oil or coolant remain.

Inspection

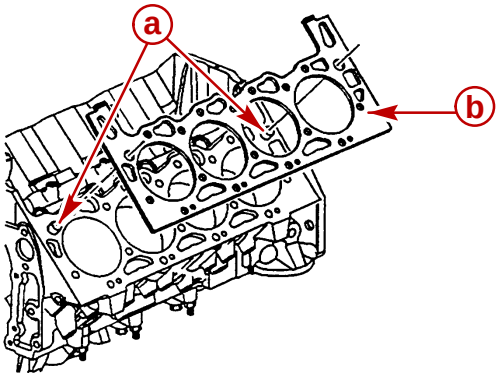
1. Inspect sealing surfaces for deep nicks and scratches.
2. Inspect for corrosion around cooling passages.
3. Inspect for cylinder head gasket leakage or corrosion.
4. Inspect pistons for carbon buildup.

Installation

⚠ CAUTION

DO NOT use sealer on head gaskets. Possible engine failure could result.

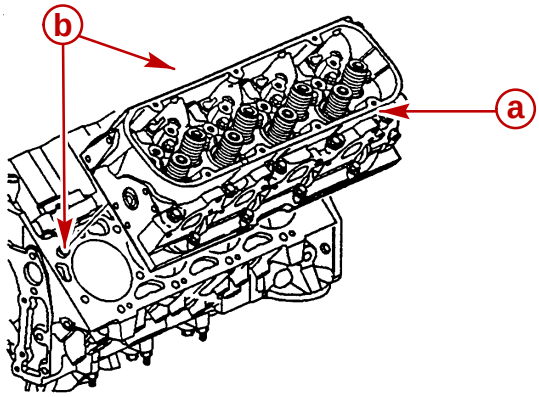
1. Place head gasket in position over dowel pins.



76700

a - Dowel Pins
b - Head Gasket

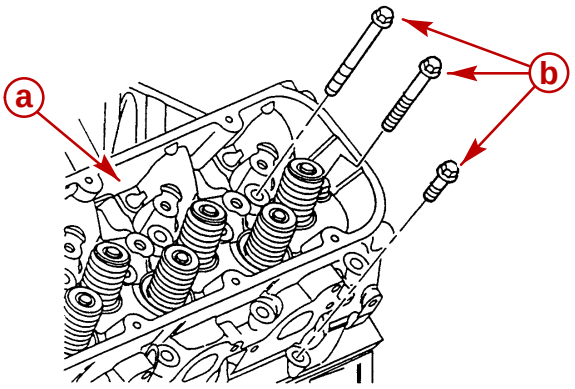
2. Align cylinder head with dowel pins and carefully set cylinder head in place.



76699

a - Cylinder Head
b - Dowel Pins (1 Not Visible)

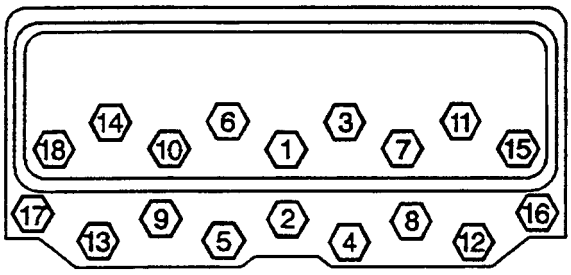
3. Coat threads of new head bolts with Quicksilver Perfect Seal and install finger-tight.



76698

a - Cylinder Head
b - Head Bolts

4. Torque head bolts in three steps, following the torque sequence. First step - 22 lb-ft (30 Nm). Second step - 120°. Final step - 30° on short bolts and 60° on medium and long bolts.



76793

Cylinder Head Torque Sequence

5. Install push rods and rocker arm assemblies in their original positions.
6. Install intake manifold.
7. Install rocker arm covers.
8. Install exhaust manifolds.
9. Install any components removed from cylinder heads.
10. Refill closed cooling system and provide adequate water supply to seawater pickup.

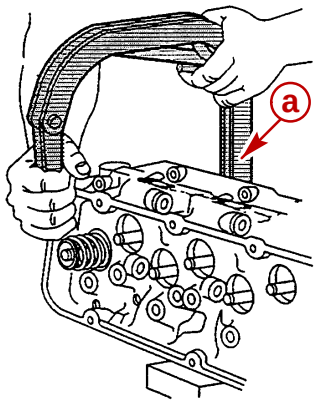
⚠ CAUTION
Ensure that cooling water supply is available before starting the engine.

11. Start engine and check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

1. Using valve spring compressor, compress valve spring and remove valve locks. Slowly release tool.



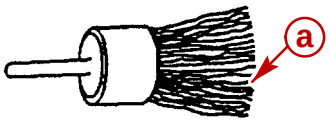
76772

a - Valve Spring Compressor (J-8062)

2. Remove all valve components.
3. Remove valves from cylinder head and place in a rack, in order, for reassembly in their original locations.

Cleaning

1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves.



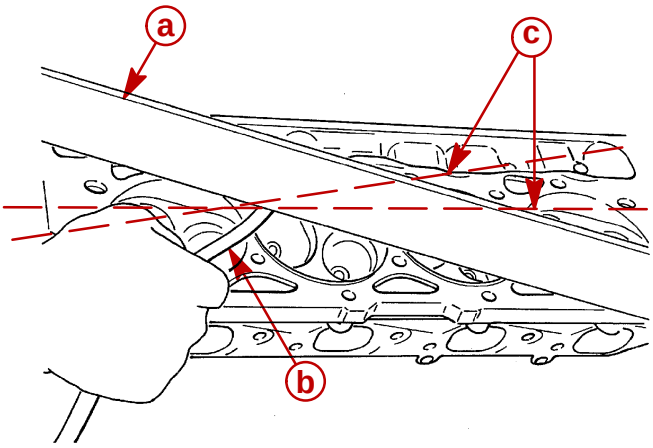
76814

a - Carbon Remover Brush (J-8358)

3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.
5. Thoroughly clean valve guides with valve guide cleaner.

Inspection

1. Inspect cylinder heads for cracks in exhaust ports, water jackets and combustion chambers (especially around spark plug holes and valve seats). Replace cylinder heads if any cracks are found.
2. Inspect cylinder head gasket surface for burrs, nicks, erosion or other damage. Also check flatness of cylinder head gasket surface using a machinist's straight edge and feeler gauges. Flatness should be checked diagonally and straight down the center of the head.

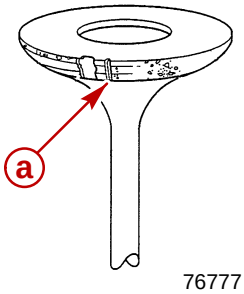


72566

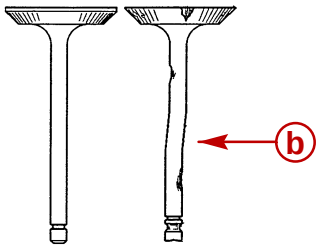
a - Straight Edge
b - Feeler Gauge
c - Measurement Lines

IMPORTANT: Cylinder head-to-block gasket surface should be resurfaced if warped more than specified. When head resurfacing is required, cylinder head-to-intake manifold gasket surface on head must be milled to provide proper alignment between intake manifold and head.

3. Inspect valves for burned heads, cracked faces or damaged stems.



76777



76776

a - Cracked And Pitted Face
b - Damaged Stems

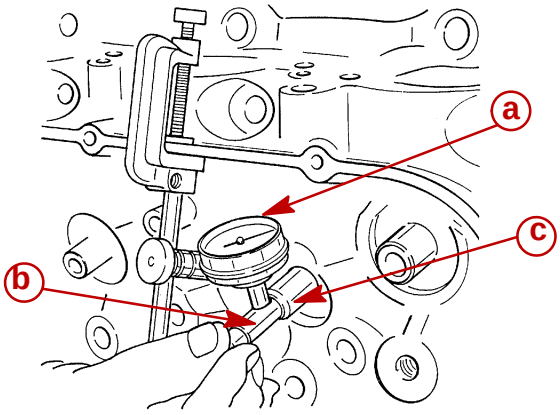
4. Inspect rocker arm nuts and push rod guides for wear and damage.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

5. Measure valve stem clearance as follows:

   a. Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.

   b. Holding valve head off seat about 1/16 in. (2 mm), move valve stem back and forth in direction shown. Compare stem clearance with specifications.



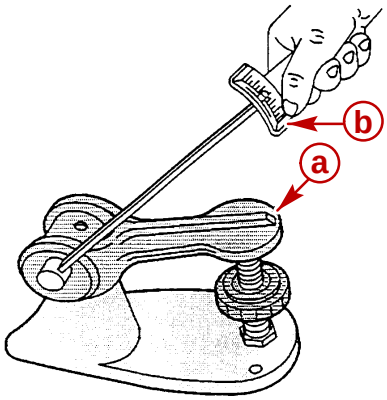
72563

a - Dial Indicator
b - Valve Stem
c - Valve Guide

   c. If clearance exceeds specifications, it will be necessary to ream valve guides for oversized valves.

Valve Springs - Checking Tension

IMPORTANT: Springs should be replaced if not within 10 lb. (44 N) of specified tension.



76778

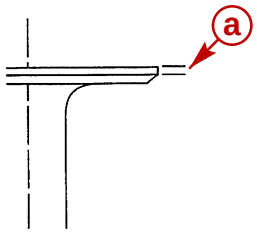
a - Valve Spring Tester (J-9666)
b - Torque Wrench

Valve Seat Repair

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to ensure that heat in valve head will be properly dispersed.

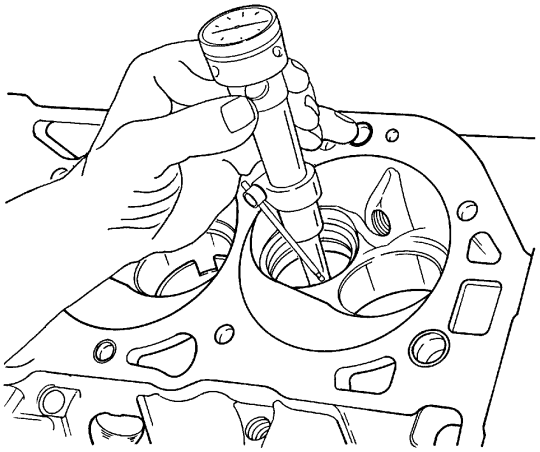
Several different types of equipment are available for reseating valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.



76781

a - Seat Width

Regardless of type of equipment, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity.



72568

Measuring Valve Seat Concentricity

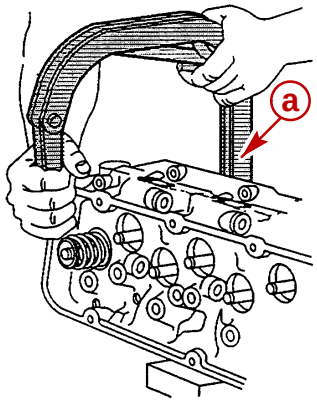
Valve Grinding

Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive wear or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1/32 in. (0.8 mm) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment being used should be carefully followed to attain proper results.

Reassembly

1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve rotators, shims, springs, seals and caps as shown under “Valve Assembly (Exploded View)”.
4. Using valve spring compressor, compress valve spring and install valve locks (grease may be used to hold locks in place).

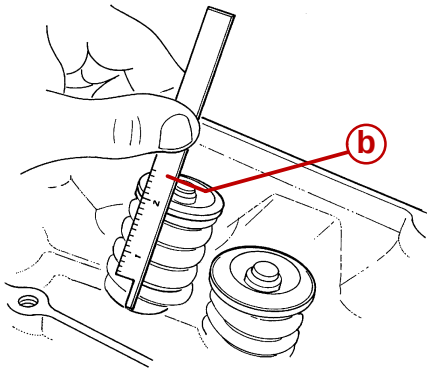


76772

a - Valve Spring Compressor (J-8062)

5. Slowly release tool, ensuring valve locks seat properly in grooves of valve stem.
6. Check installed height of valve springs using a narrow, thin scale cutaway as shown. Measure from spring seat to top of valve spring, as shown. If measurement exceeds specified height, install a valve spring shim and recheck. DO NOT shim valve springs to give an installed height less than the minimum specified.

50037



72562

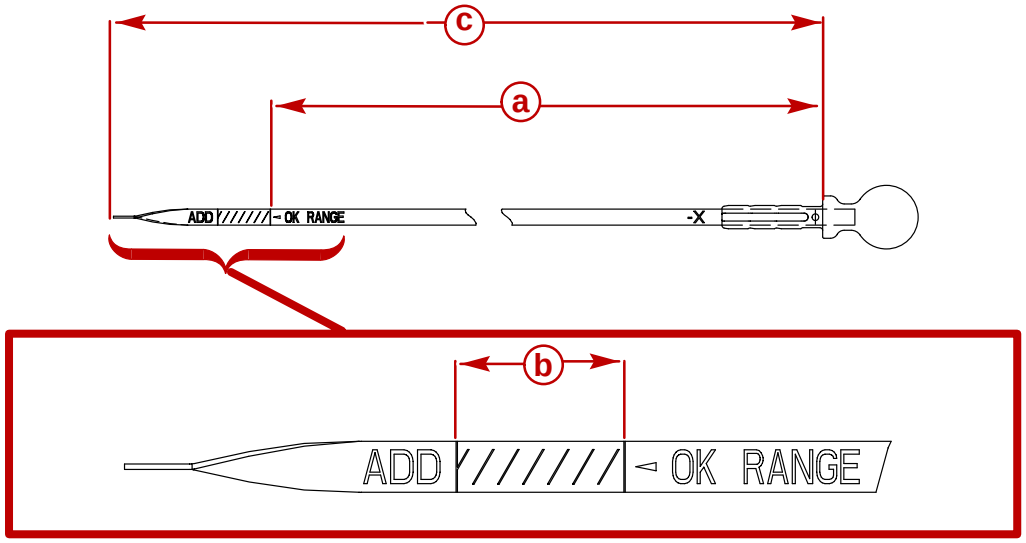
a - Cut Away This Portion 1/2 Inch (13 mm)
b - Valve Spring Installed Height

Crankcase Oil Dipstick Specifications

All Engines

NOTICE
Unit Of Measurement: inches (millimeters)

Part Number	Length “A”	Length “A” Tolerance	Length “B”	Length “B” Tolerance	Length “C”	Length “C” Tolerance	Model
861942-10	39.67 (1008)	+/– .031 (.79)	.375 (9.5)	+/– .031 (.79)	42.375 (1076)	+/– .125 (3)	8.1L MCM
861942-11	24.13 (613)	+/– .031 (.79)	.375 (9.5)	+/– .031 (.79)	26.630 (676)	+/– .125 (3)	8.1L MIE
861942-12	40.00 (1016)	+/– .031 (.79)	.375 (9.5)	+/– .031 (.79)	42.500 (1080)	+/– .125 (3)	8.1L MIE V-Drive



77646

a - Length “A”
b - Length “B”
c - Length “C”

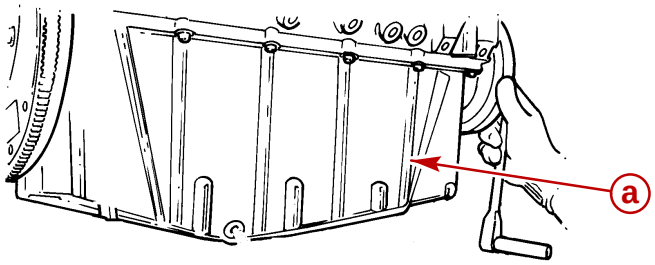
Oil Pan

Removal

1. Drain crankcase oil.
2. Remove dipstick and tube.

IMPORTANT: DO NOT move or disturb the orientation of fitting on bottom of pan or incorrect oil level readings may be obtained.

3. Remove cool fuel cell on port side.
4. Remove oil pan.



77049

a - Oil Pan

Inspection

1. Remove oil pan baffle.
2. Inspect oil pan for wear and oil buildup.
3. Clean or replace oil pan as necessary.
4. Install oil pan baffle.

Installation

1. Clean sealing surfaces of engine block and oil pan.
2. Apply a small amount of Quicksilver RTV Sealer to joints of rear seal retainer and joints of front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

3. Install oil pan gasket in position on oil pan.

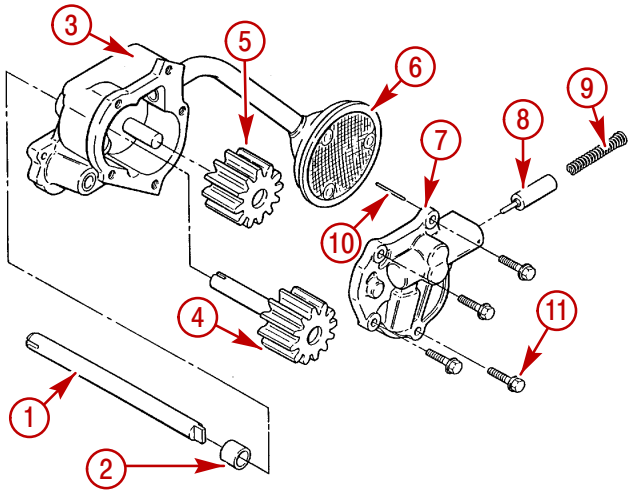
NOTE: *A one-piece oil pan gasket may be re-used if it is still pliable and is not cracked, torn or otherwise damaged.*

4. Install oil pan. Starting from the center and working outward in each direction, torque to 19 lb-ft (25 Nm).
5. Install dipstick tube(s) and dipstick(s). Ensure dipstick tubes are reassembled in original locations.

IMPORTANT: DO NOT move or disturb the orientation of fitting on bottom of pan or incorrect oil level readings may be obtained.

6. Fill crankcase with required quantity of oil of specified viscosity.

Oil Pump



72277

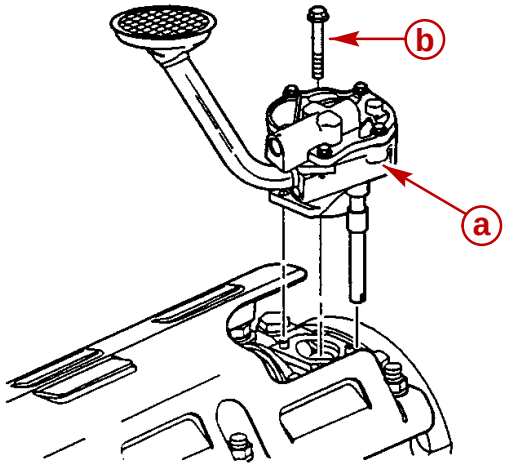
Oil Pump Assembly

1 - Extension Shaft
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Retaining Pin
11 - Screws

The oil pump consists of two gears and a pressure regulator valve enclosed in a two–piece housing. Oil pump is driven by oil pump drive which is driven by a helical gear on camshaft.

Removal

1. Remove oil pan.
2. Remove oil pump.



76707

a - Oil Pump
b - Oil Pump Bolt

Disassembly

1. Remove pump cover.

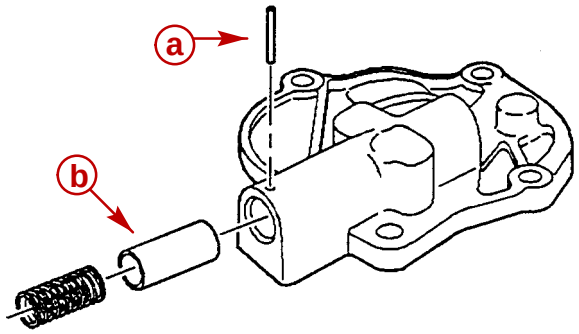
IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear and drive gear from pump body.

⚠ CAUTION

Regulator valve spring is compressed use care when removing retaining pin.

3. Remove retaining pin from pump cover with a punch. Spring may release violently.
4. Remove pressure regulator valve from pump cover.



76788

a - Retaining Pin
b - Pressure Regulator Valve

Cleaning

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Oil pump is not serviceable. If any parts are worn or damaged, replace pump assembly and pickup tube.

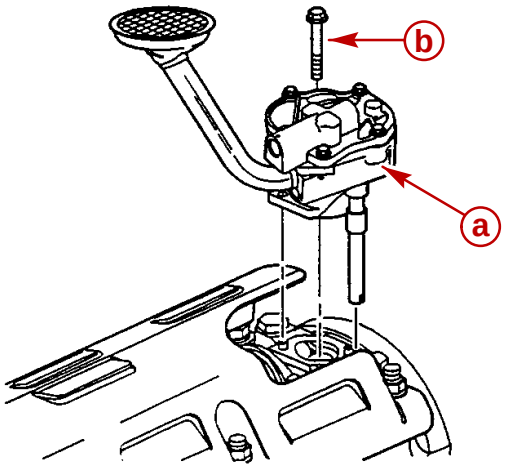
Reassembly

IMPORTANT: Coat internal parts with oil liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Fill gear cavity with engine oil.
5. Install pump cover and torque attaching screws to 106 lb-in. (12 Nm).
6. Turn extension shaft by hand to check for smooth operation.

Installation

1. Install pump, with extension shaft, to rear main bearing, aligning extension shaft with oil pump drive.
2. Tighten oil pump bolt to 56 lb-ft. (75 Nm).



76707

a - Oil Pump
b - Oil Pump Bolt

3. Install oil pan.

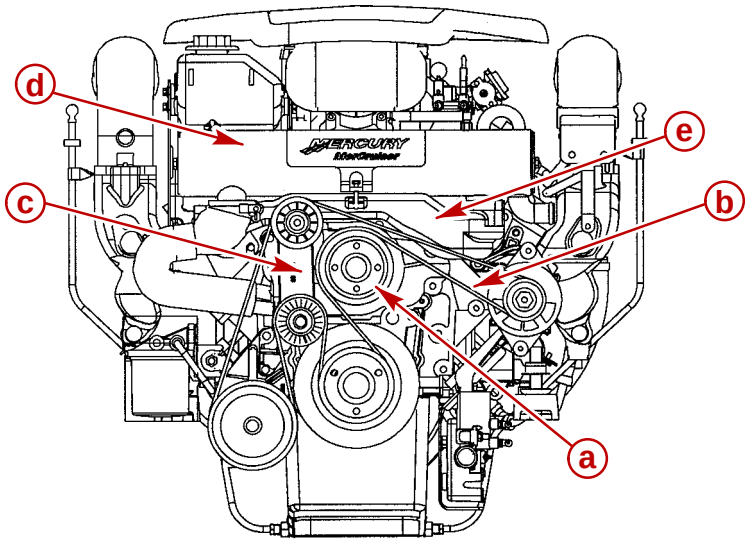
Water Circulating Pump

Removal

1. Drain engine coolant system.
2. Remove water circulating pump pulley using either a or b:
   a. Using tool J-41240 to prevent rotation, remove pulley bolts.
   b. With drive belt installed to prevent rotation, remove pulley bolts.

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

3. Remove drive belt.
4. Remove dual idler pulley bracket.
5. Loosen hose clamps on water circulating pump and heat exchanger.
6. Remove heat exchanger and crossover.



77627

a - Water Circulating Pump Pulley
b - Drive Belt
c - Dual Idler Pulley Bracket
d - Heat Exchanger
e - Crossover

Inspection

1. Inspect for cracks or wear in water pump body.
2. Inspect pulley shaft for out of round or bent position.
3. Inspect sealing surfaces for cuts, scratches or debris.
4. Clean sealing surfaces on pump and block.

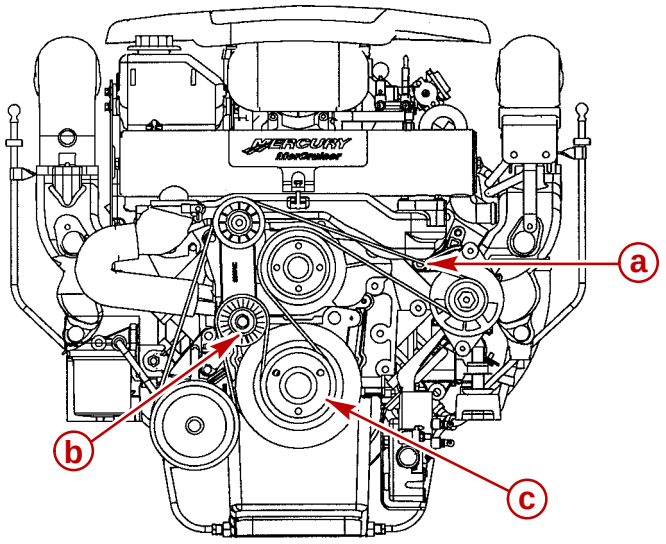
Installation

1. Apply Loctite Perfect Seal to threads of water circulating pump bolts.
2. Align gaskets and water pump onto engine.
3. Fasten water circulating pump to engine with 4 bolts and torque to 37 lb-ft (50 Nm).
4. Install crossover and heat exchanger.
5. Install hoses.
6. Install dual idler bracket.
7. Install water pump pulley.
8. Install drive belt.
9. Fill cooling system.

Torsional Damper

Removal

1. Remove drive belt.
2. Remove idler pulley.
3. Remove crankshaft pulley.



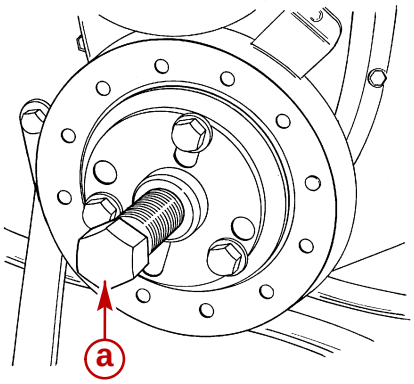
77627

a - Drive Belt
b - Idler Pulley
c - Crankshaft Pulley

4. Remove torsional damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of torsional damper is bonded in rubber to the hub. Use of claw type puller may break the bond.

5. Remove torsional damper with Torsional Damper Remover and Installer.



72345

a - Torsional Damper Remover and Installer (J-23523-E)

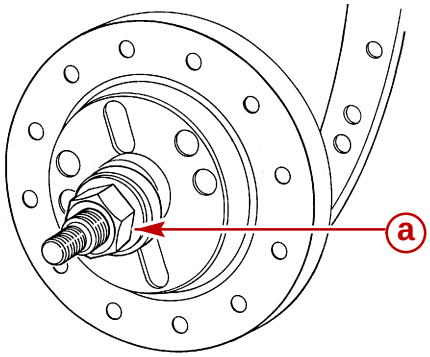
Installation

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Coat seal surface of torsional damper with engine oil.
2. Install torsional damper on crankshaft, using Torsional Damper Remover and Installer as follows:
   a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft at least 1/2 in. (13 mm) to prevent damage to threads.

   b. Install plate, thrust bearing, washer and nut on rod.
   c. Install torsional damper on crankshaft by turning nut until it contacts.



72346

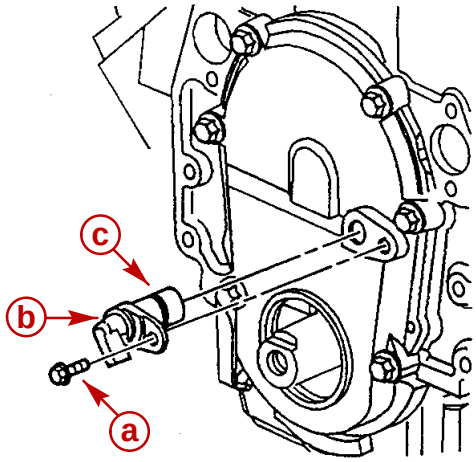
a - Torsional Damper Remover and Installer (J-23523-E)

   d. Remove tool from crankshaft.
   e. Install torsional damper bolt. Torque to 188 lb-ft. (225 Nm).
3. Install crankshaft and idler pulleys.
4. Install and adjust drive belt.

Camshaft Position Sensor

Removal

1. Remove female hex fastener.
2. Remove camshaft position sensor.



76709

a - Female Hex Fastener
b - Camshaft Position Sensor
c - O-Ring

3. Remove and discard o-ring.

Inspection

1. Inspect sensor for excessive wear or gouges. Replace if necessary.

Installation

1. Install new o-ring onto camshaft position sensor.

IMPORTANT: Ensure o-ring is fully seated in groove of camshaft position sensor before installing sensor into front cover.

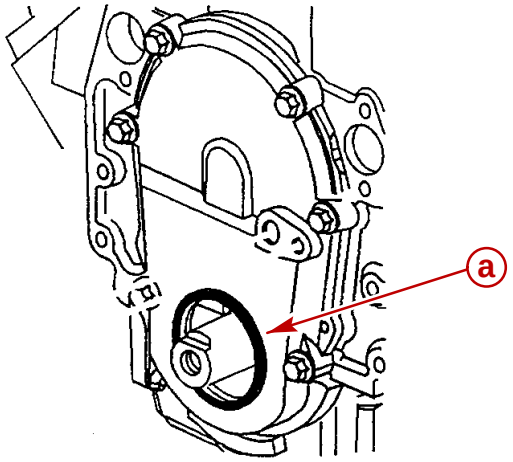
2. Firmly press camshaft position sensor into front cover.
3. Install female hex fastener. Torque to 106 lb-in. (12 Nm).

Front Cover / Oil Seal

Oil Seal Replacement (Without Removing Front Cover)

REMOVAL

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft.

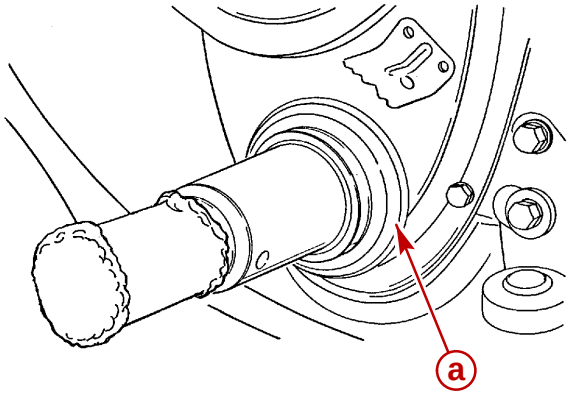


76709

a - Oil Seal

INSTALLATION

1. Apply Quicksilver Perfect Seal to seal retainer mating surfaces and apply grease to seal lips.
2. Install new seal with open end of seal inward (lip of seal toward inside of engine), using front cover seal installer. Drive seal in until it contacts. Do not use excessive force.



72560

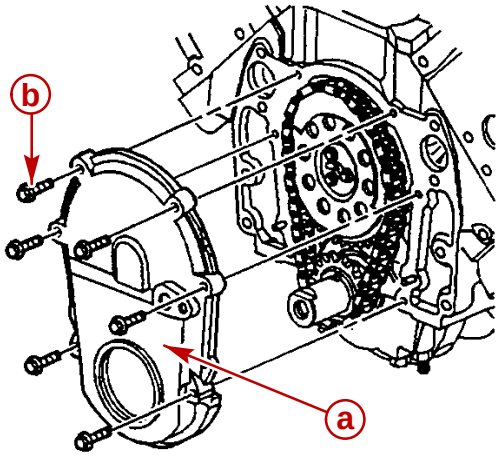
a - Front Cover Seal Installer (J-22102)

3. Reinstall torsional damper.

Front Cover

Removal

1. Remove engine from boat.
2. Drain closed cooling system.
3. Remove belt.
4. Remove heat exchanger and crossover.
5. Remove water circulating pump.
6. Remove torsional damper.
7. Remove camshaft position sensor.
8. Remove front cover bolts.



76710

a - Front Cover
b - Bolts

9. Using a screwdriver, carefully remove front cover.
10. If damaged, drive oil seal out of front cover (from the rear) using a punch.

Cleaning

1. Clean front cover in solvent and dry with compressed air.
2. Clean old gasket material and sealer from mating surfaces on cover and cylinder block.

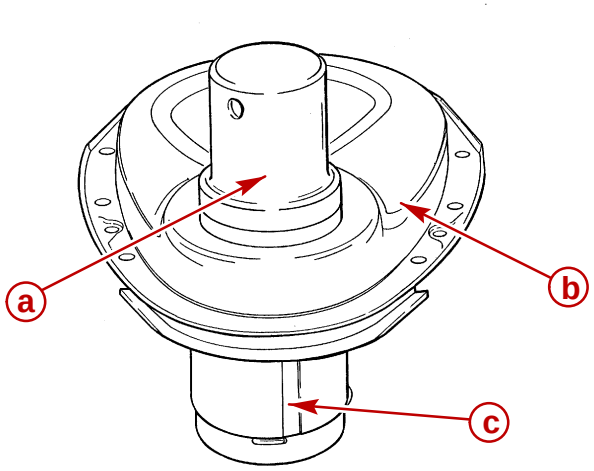
Inspection

IMPORTANT: The front cover is cast aluminum that has a molded o-ring style gasket. This gasket is retained in a cast groove. The gasket must be replaced if damaged.

1. Check gasket surface on front cover for distortion, and correct if necessary. Surfaces must be clean and flat or oil leakage may result.

Installation

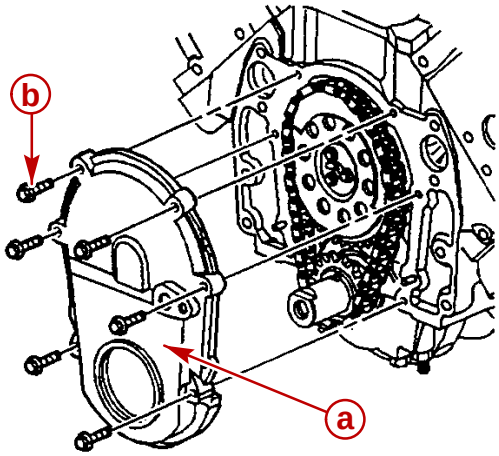
1. Install oil seal in cover with lip of seal toward inside of engine, using front cover seal installer. Support cover around seal area with appropriate tool.



72945

a - Front Cover Seal Installer (J-22102)
b - Front Cover
c - Support Tool

2. Coat both sides of front cover gasket with Quicksilver Perfect Seal and place in position on engine.
3. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover bolts to 106 lb-in. (12 Nm).



76710

a - Front Cover
b - Bolts

4. Install camshaft position sensor.
5. Install torsional damper.
6. Install water circulating pump.
7. Install heat exchanger and crossover.
8. Install drive belt.
9. Fill crankcase with engine oil.
10. Refill closed cooling section and provide adequate water supply to seawater pickup.

⚠ CAUTION

Ensure that cooling water supply is available before starting the engine.

11. Start engine and check for water and oil leaks.

Flywheel Housing

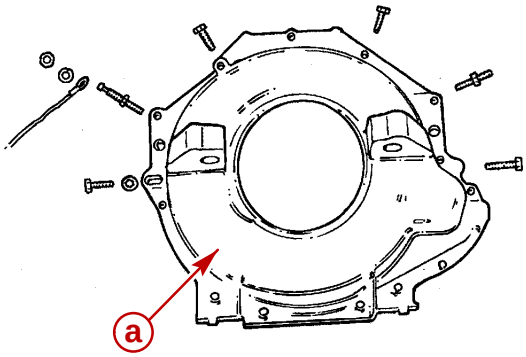
Removal

IMPORTANT: Use caution when removing water hoses. Do not bend ends of power steering cooler.

1. Remove water hoses from power steering cooler.
2. Remove power steering cooler.
3. Remove ground wires from flywheel housing.

IMPORTANT: Flywheel housing bolts must be installed in same location as removed.

4. Remove bolts from flywheel housing.
5. Remove flywheel housing.



77444

a - Flywheel Housing

Inspection

1. Visually inspect flywheel housing for crack, holes and excessive wear.
2. Replace if necessary.

Installation

1. Align flywheel housing onto guide dowels on engine.

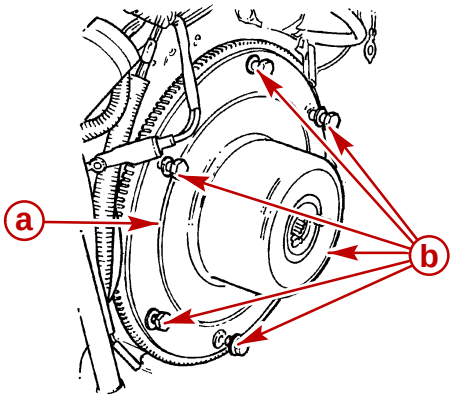
IMPORTANT: Flywheel housing bolts must be installed in same location as removed.

2. Install 2 studs and 4 bolts.
3. Torque to 30 lb-ft. (41 Nm).
4. Install power steering cooler, hoses and other components removed previously.

MCM Coupler / MIE Drive Plate

Removal

1. Remove flywheel housing.
2. Remove 6 bolts and lockwashers fastening coupler to engine.



77471

Typical Coupler Mounting

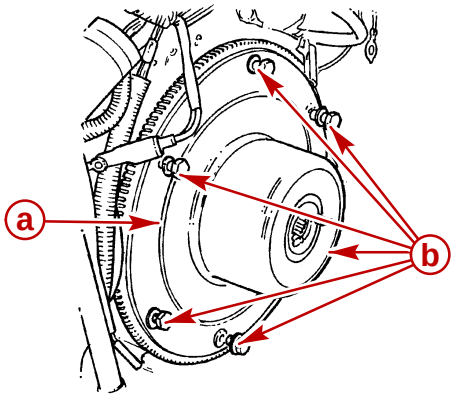
a - Coupler
b - Bolts (1 Hidden)

Inspection

1. Inspect splines in drive plate or coupler for wear.
2. Inspect drive plate or coupler for warping.
3. Replace as necessary.

Installation

1. Install coupler with 6 bolts and lockwashers.



77471

Typical Coupler Mounting

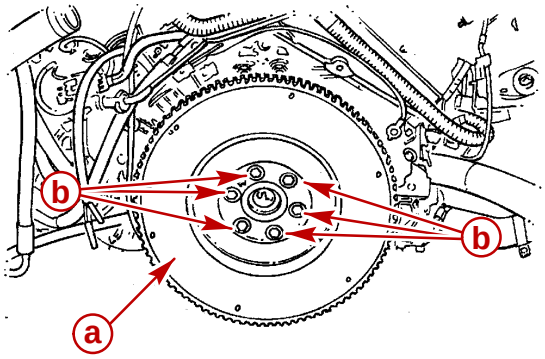
a - Coupler
b - Bolts (1 Hidden)

2. Install flywheel housing.

Flywheel

Removal

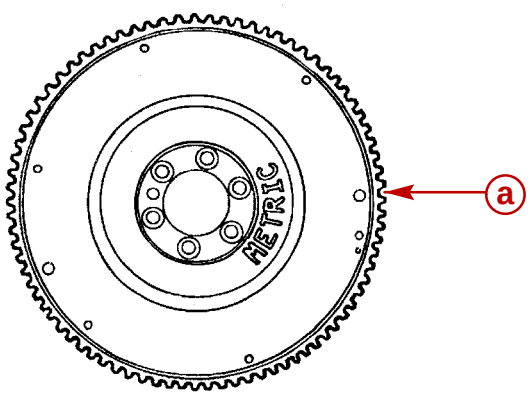
1. Remove drive unit.
2. Remove engine from boat.
3. Remove transmission, if equipped.
4. Remove flywheel housing.
5. Remove MCM coupler or MIE drive plate.
6. Remove bolts retaining flywheel to engine.



77470

a - Flywheel
b - Bolts

Inspection



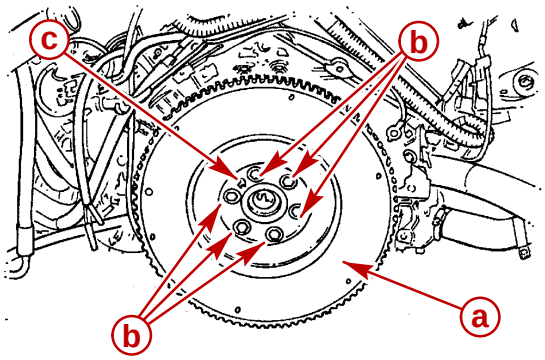
77469

a - Flywheel Ring Gear

1. Check flywheel ring gear for worn and missing teeth.
2. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.

Installation

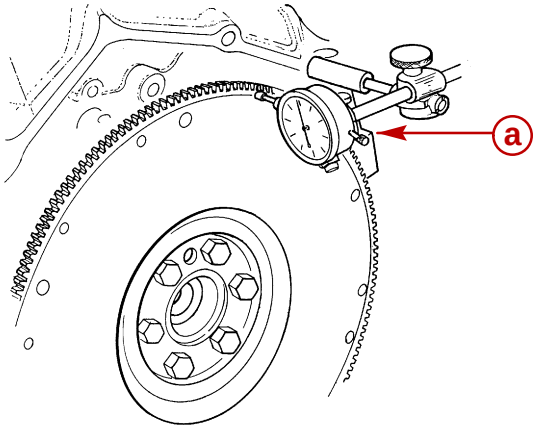
1. Align dowel hole in flywheel with dowel in crankshaft.
2. Install flywheel. Torque bolts to 74 lb-ft (100 Nm).



77470

a - Flywheel
b - Bolts
c - Dowel Hole

3. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block.
   b. Take readings around outer edge of flywheel. Push in on flywheel to remove crankshaft end play.
   c. Maximum runout - .008 in. (0.203 mm).



72353

a - Dial Indicator

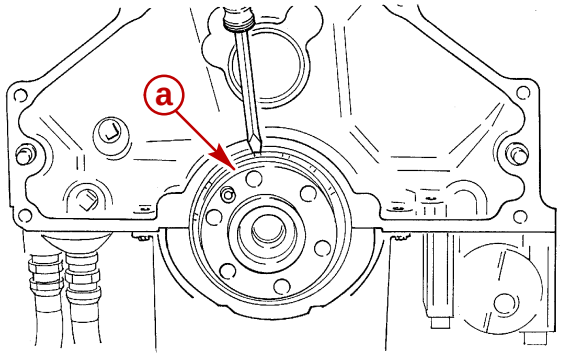
4. Install drive coupler or drive plate.
5. Install flywheel housing and related parts.
6. Install flywheel housing cover.
7. Install transmission (MIE only). Torque bolts to 50 lb-ft (68 Nm).
8. Refer to SECTION 2 - Removal and Installation. Install engine.

Rear Main Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

1. Remove seal by using a screwdriver to pry it out of engine block.



72559

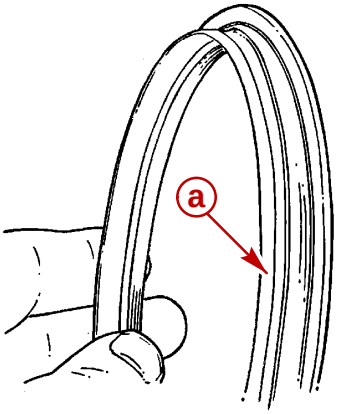
a - Rear Main Seal (Crankshaft Oil Seal)

IMPORTANT: Do not nick or gouge the engine block or rear main bearing cap sealing surface. Protect end of crankshaft and crankshaft/seal running surface from damage, also.

Cleaning and Inspection

Clean crankshaft/seal running surface and seal retainer.

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.

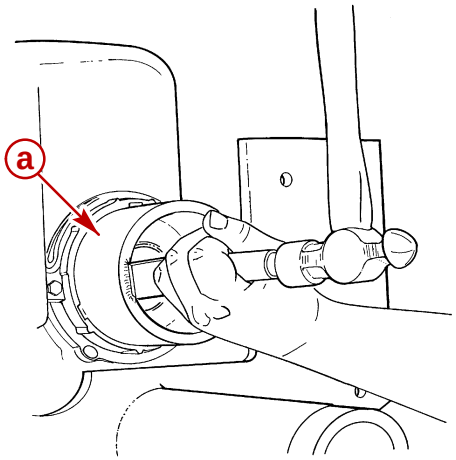


77468

a - Seal Lip Toward Inside Of Engine

Installation

1. Apply Quicksilver Perfect Seal to engine block/seal mating surface. Apply grease to seal lips.
2. Install seal using rear main seal installer or suitable device.

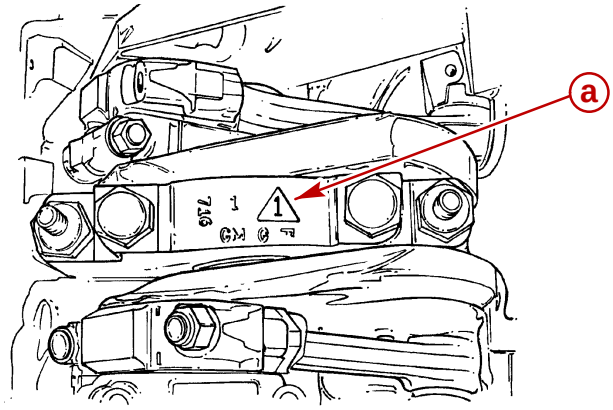


72356

a - Suitable Device Shown (Rear Main Seal Installer J-38841 Not Shown)

Main Bearings

IMPORTANT: Before removing main bearing caps or connecting rod caps, mark them for reassembly in their original locations.



77467

a - Main Bearing Cap Mark

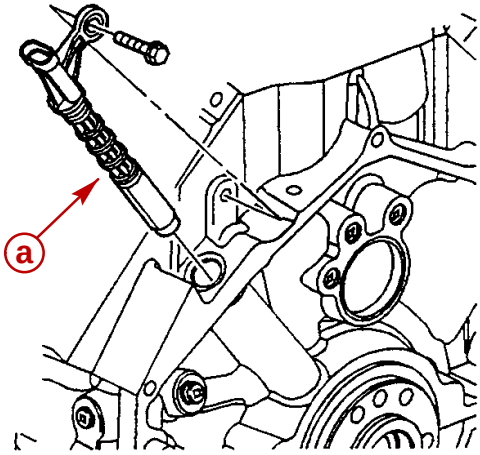
Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001 in., .002 in., .010 in. and .020 in. undersize.

Inspection

In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Removal

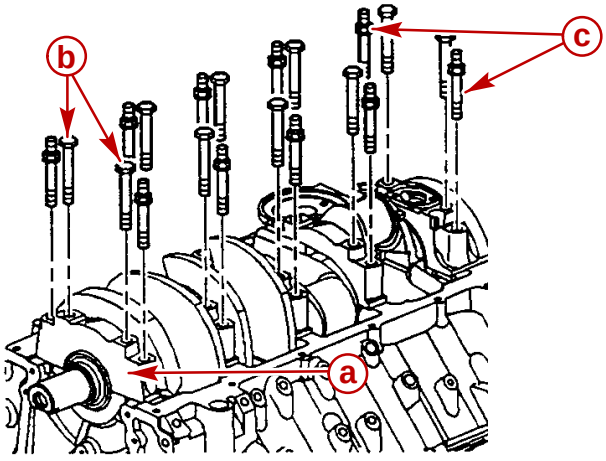
1. Remove oil pan, oil pump and crankshaft oil deflector.
2. Mark bearing caps for reassembly.
3. Remove crankshaft position sensor.



76720

a - Crankshaft Position Sensor

4. Remove bearing caps.



76721

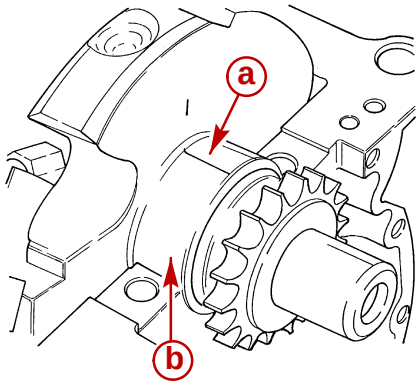
a - Main Caps
b - Inner Bolts
c - Outer Studs

Checking Clearances

To obtain accurate measurements while using Plastigage, or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

1. Remove bearing cap to be checked.
2. Wipe oil from journal and bearing cap to be inspected.
3. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.

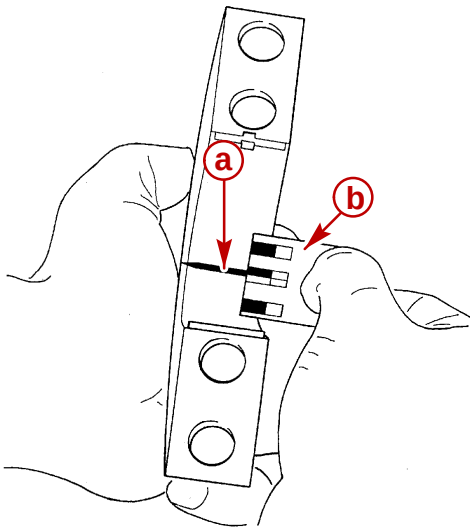
IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.



72558

a - Gauging Plastic
b - Journal

4. Install the bearing cap and evenly tighten the retaining bolts.
5. Remove bearing cap. The flattened gauging plastic will adher to either the bearing cap or journal.
6. Do not remove the gauging plastic. Measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope as shown.

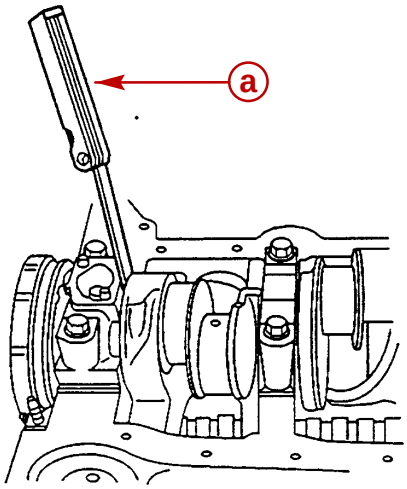


72557

a - Compressed Gauging Plastic
b - Graduated Scale

NOTE: *Normally main bearing journals wear evenly and are not out of round. However, if a bearing is being fitted to an out-of-round journal (.001 in. max.), be sure to fit to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter, and the journal is out of round .001 in., interference between the bearing and journal will result in rapid bearing failure. If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.*

7. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
8. A standard or .001 in. undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.
9. Repeat steps 1-7 for each bearing cap.
10. After all bearings have been checked, rotate the crankshaft to check for drag.
11. Measure crankshaft end play by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge.

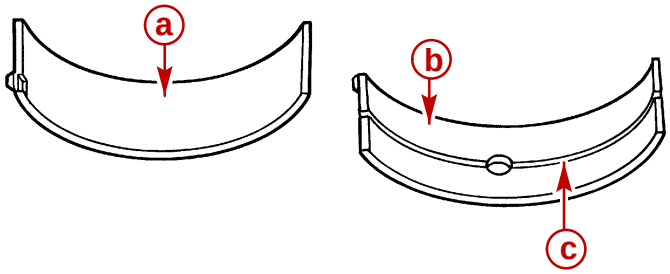


76754

a - Feeler Gauges

Installation

NOTE: *Main bearings may be replaced with or without removing crankshaft.*

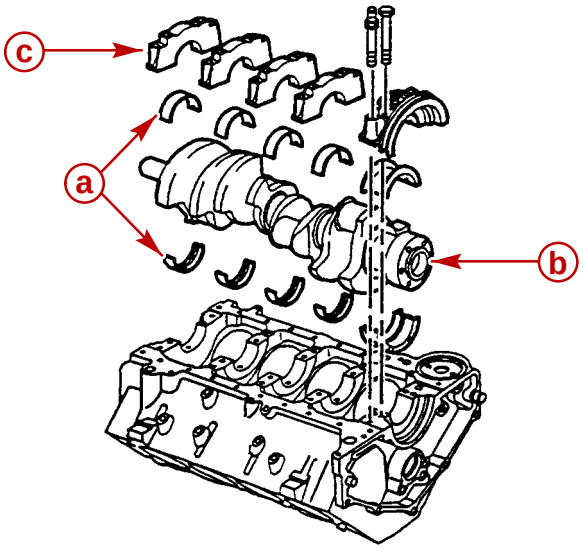


72359

a - Lower Bearing Insert (Install In Cap)
b - Upper Bearing Insert (Install In Block)
c - Oil Groove

WITH CRANKSHAFT REMOVED

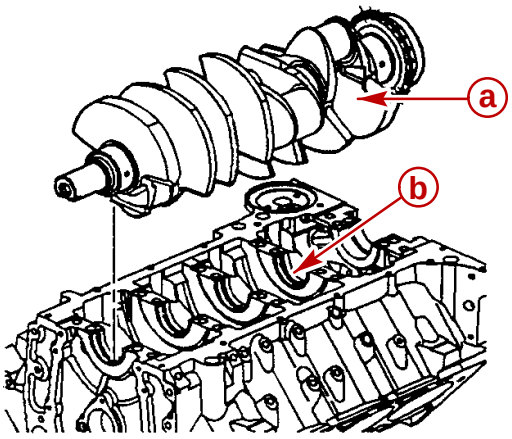
1. Remove and inspect the crankshaft.
2. Remove the main bearings from the cylinder block and main bearing caps.



76750

a - Main Bearings
b - Crankshaft
c - Main Bearing Caps

3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.
4. Install the crankshaft.



76723

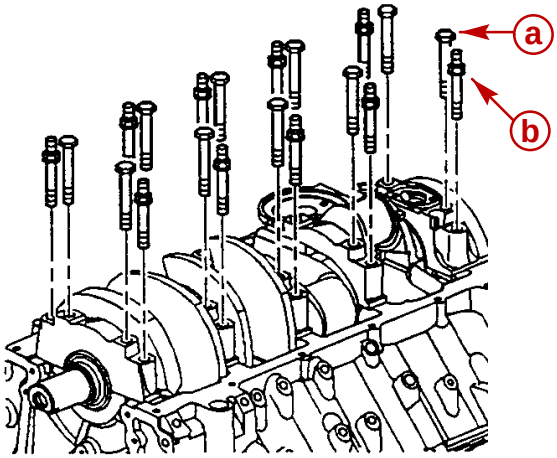
a - Crankshaft
b - Upper Main Bearings

⚠ CAUTION

Main bearing caps must be tapped into the cylinder block cavity using a brass, or leather mallet to ensure proper seating. Do NOT use the attaching bolts to pull the main bearing caps into place.

IMPORTANT: Ensure that the triangle symbols on the main bearing caps are facing the front of the engine.

5. Install the main bearing caps, except the rear main bearing.
6. Torque main bearing caps, in the following sequence.
   a. Inner bolts to 22 lb-ft. (30 Nm).
   b. Outer studs to 22 lb-ft. (30 Nm).
   c. Inner bolts an additional 90 degrees
   d. Outer studs an additional 80 degrees.

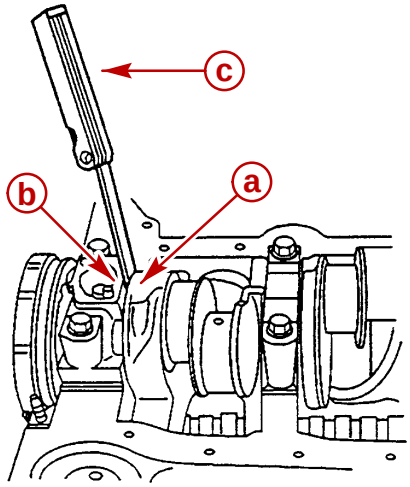


76721

a - Inner Bolts
b - Outer Studs

7. Apply a 1/2 in. (13 mm) film of GM P/N 1052942 or equivalent to the rear main bearing cap face.
8. Install the rear main bearing.
9. Torque fasteners to 35 lb-in. (4 Nm) starting with the inner bolts.
10. Firmly thrust the crankshaft, first rearward then forward with a hammer. This will line up rear main bearing and crankshaft thrust surfaces. Then torque rear main bearing cap in the following sequence.
    a. Inner bolts to 22 lb-ft. (30 Nm).
    b. Outer studs to 22 lb-ft. (30 Nm).
    c. Inner bolts an additional 90 degrees
    d. Outer studs an additional 80 degrees.

11. With the crankshaft wedged forward,check clearance between the thrust bearing and the crankshaft thrust surface with a feeler gauge. Proper clearance is .005-.011 in. (.127-.279 mm).



76754

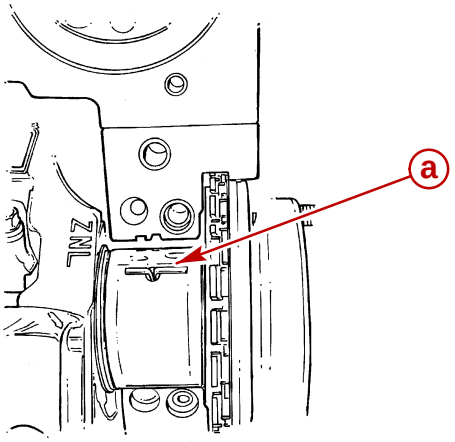
a - Crankshaft Thrust Surface
b - Thrust Bearing
c - Feeler Gauge

WITHOUT CRANKSHAFT REMOVED

IMPORTANT: Inspect bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.

1. With oil pan, oil pump, baffle and spark plugs removed, make suitable marks on cap and remove cap on main bearing requiring replacement. Remove bearing from cap.
2. Install main bearing remover/installer in oil hole in crankshaft journal. If tool is not available, a cotter pin may be bent as shown.

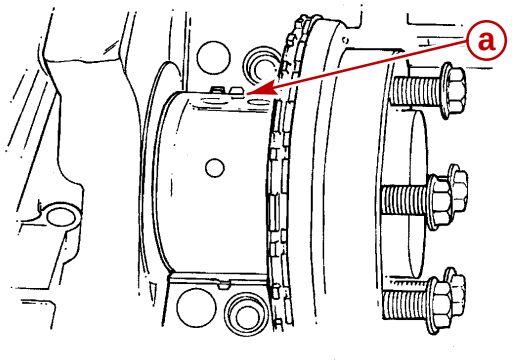
NOTE: *If using cotter pin method, ensure flatness to prevent scratching journal surface.*



77463

a - Cotter Pin

3. Rotate the crankshaft clockwise as viewed from the front of the engine. This will roll upper bearing out of block.
4. Oil new upper bearing and place on crankshaft.
5. Insert plain end between crankshaft and indented or notched side of block. Verify notch will align properly. Rotate and remove tool from oil hole in crankshaft journal.



77477

a - Notched Side Of Block

6. Oil new lower bearing and install in bearing cap.

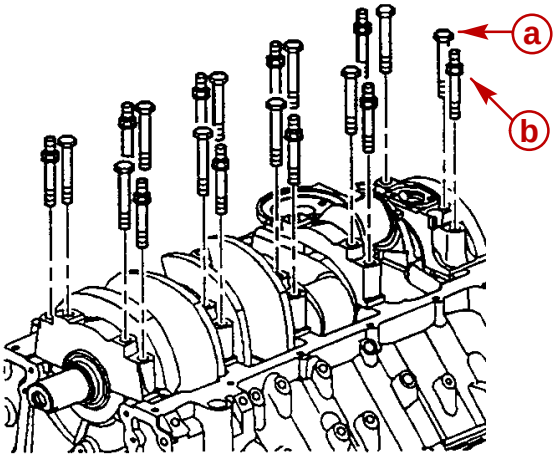
⚠ CAUTION

Main bearing caps must be tapped into the cylinder block cavity using a brass, or leather mallet to ensure proper seating. Do NOT use the attaching bolts to pull the main bearing caps into place.

IMPORTANT: Ensure that the triangle symbols on the main bearing caps are facing the front of the engine.

7. Install the main bearing caps, except the rear main bearing.

8. Torque main bearing caps, in the following sequence.
   a. Inner bolts to 22 lb-ft. (30 Nm).
   b. Outer studs to 22 lb-ft. (30Nm).
   c. Inner bolts an additional 90 degrees
   d. Outer studs an additional 80 degrees.

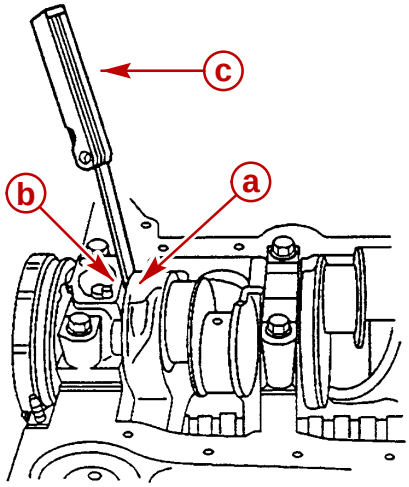


76721

a - Inner Bolts
b - Outer Studs

9. Apply a 1/2 in. (13 mm) film of GM P/N 1052942 or equivalent to the rear main bearing cap face.
10. Install the rear main bearing.
11. Torque fasteners to 35 lb-in. (4Nm) starting with the inner bolts.
12. Firmly thrust the crankshaft, first rearward then forward with a hammer. This will line up rear main bearing and crankshaft thrust surfaces. Then torque rear main bearing cap in the following sequence.
    a. Inner bolts to 22 lb-ft. (30 Nm).
    b. Outer studs to 22 lb-ft. (30Nm).
    c. Inner bolts an additional 90 degrees
    d. Outer studs an additional 80 degrees.

13. With the crankshaft wedged forward,check clearance between the thrust bearing and the crankshaft thrust surface with a feeler gauge. Proper clearance is .005-.011 in. (.127-.279 mm).



76754

a - Crankshaft Thrust Surface
b - Thrust Bearing
c - Feeler Gauge

Connecting Rod Bearings

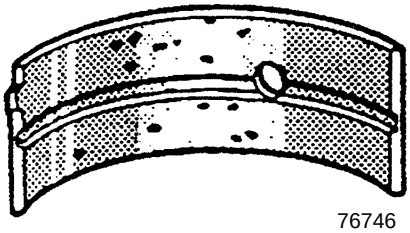
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size ,.001 in. and .002 in. undersize for use with new and used standard size crankshafts, and in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

Inspection and Replacement

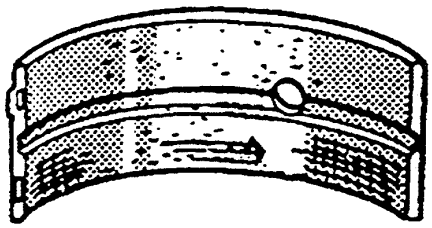
IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number and remove one connecting rod cap and bearing.

1. Remove oil pan, oil pump and both oil baffles.
2. Mark the side of the rod and cap with the cylinder number and remove one connecting rod cap and bearing.

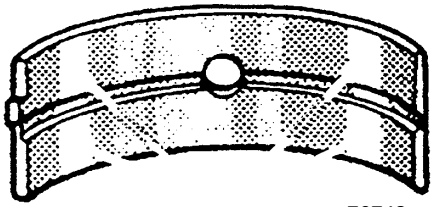
3. Inspect the bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.



76746



76747

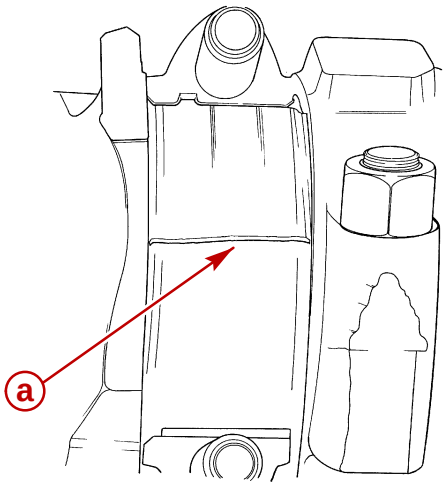


76748

4. Wipe both upper and lower bearing shells and crank pin clean of oil.
5. Measure the crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition the crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the to determine new bearing size required.

6. If within specifications, measure new or used bearing clearances with gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round.001 in., interference between the bearing and crankpin will result in rapid bearing failure.

   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown. Position the gauging plastic in the middle of the bearing shell. (Bearings are eccentric and false readings could occur if placed elsewhere.)

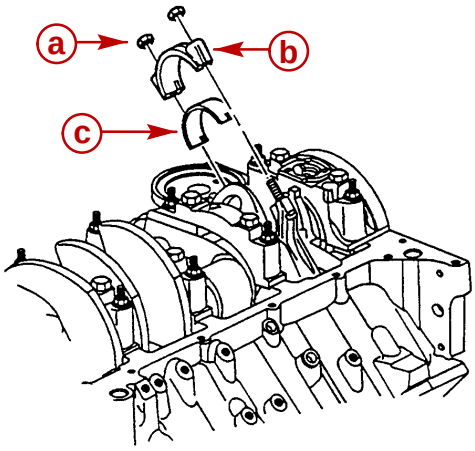


72361

a - Gauging Plastic

   b. Install the bearing in the connecting rod and connecting rod cap.

   c. Install the bearing cap and evenly torque nuts to 22 lb-ft. (30 Nm). Then tighten an additional 90 degrees.

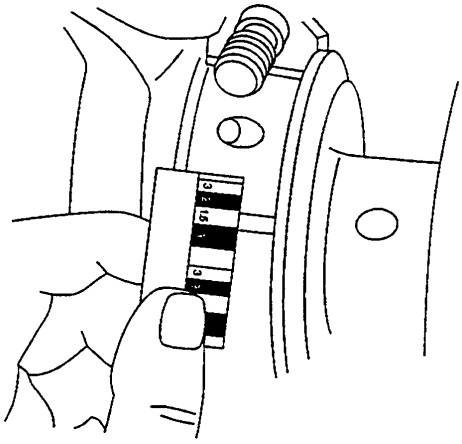


76753

a - Connecting Rod Nut
b - Connecting Rod Cap
c - Connecting Rod Bearing

d. Remove the bearing cap and using the scale on the gauging plastic envelope, measure the gauging plastic width the widest point as shown.

IMPORTANT: Do not turn the crankshaft with the gauging plastic installed.

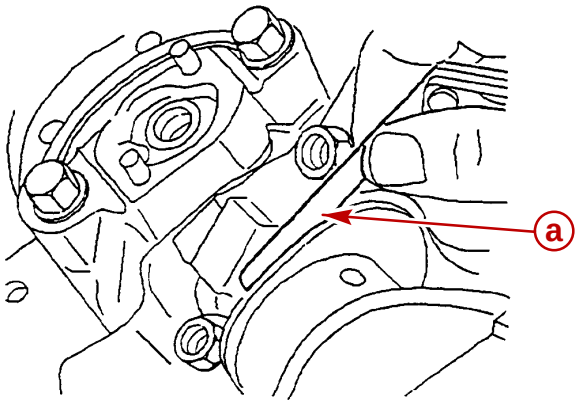


76751

7. If the clearance exceeds specifications, select a new, correct size bearing and measure the clearance.

Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought to within specifications, the crankshaft journal will have to be ground undersize. If the crankshaft journal is already at maximum undersize, replace crankshaft.

8. Coat the bearing surface with oil. Install the rod cap and torque nuts 22 lb-ft. Then tighten an additional 90 degrees.
9. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) .
10. Using feeler gauges, measure all connecting rod side clearances between connecting rod caps.



76755

a - Feeler gauge

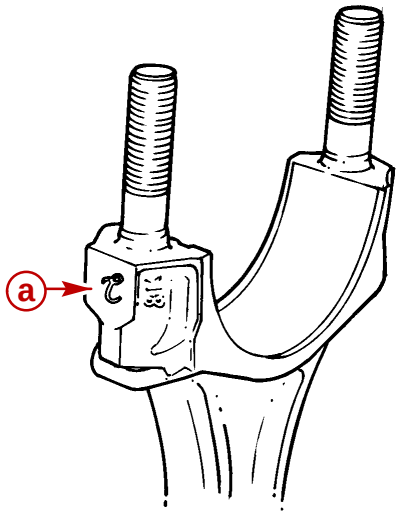
Connecting Rod / Piston Assembly

Removal

1. Remove oil pan.
2. Remove baffles, crankshaft deflector and oil pump.
3. Remove intake manifold, throttle body and fuel rail.
4. Remove exhaust manifolds.
5. Remove cylinder heads.
6. Use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

7. Mark connecting rods and bearing caps (left bank 1, 3, 5 and 7; right bank 2, 4, 6, and 8 from front to rear on same side as piston thrust).

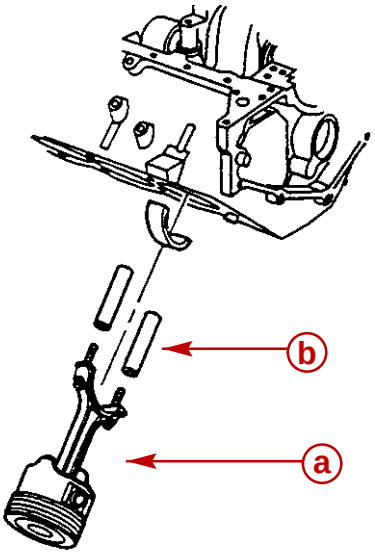


77481

a - Connecting Rod Bearing Mark

8. Remove connecting rod cap and install connecting rod bolt guide on bolts.

9. Push connecting rod and piston assembly out of top of cylinder block.



76718

a - Piston And Rod Assembly
b - Rod Bolt Guide

NOTE: *It will be necessary to turn crankshaft to disconnect and remove some connecting rod and piston assemblies.*

Cleaning and Inspection

CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods.
3. Inspect for nicks and cracks.
4. Replace as necessary.

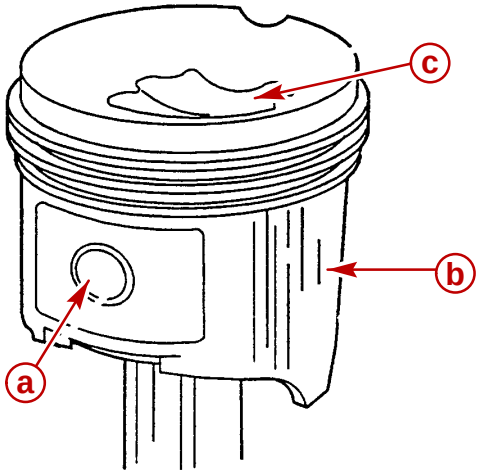
PISTONS

IMPORTANT: DO NOT USE A WIRE BRUSH ON ANY PART OF THE PISTON.

NOTE: *Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

1. Clean varnish from piston skirts with a cleaning solvent.
2. Clean ring grooves.
3. Ensure oil ring holes are clean.
4. Inspect piston top and skirt for damage and signs of excessive wear. Replace pistons, if necessary.

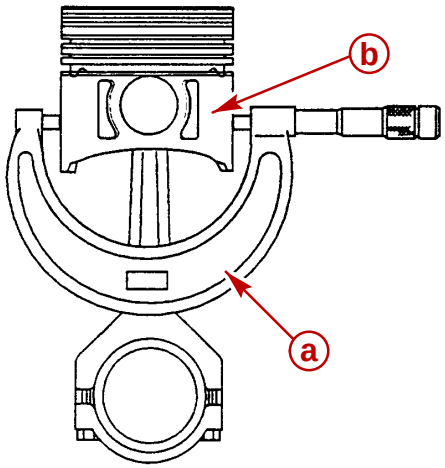
5. Inspect grooves for nicks and burrs.



76757

a - Pin And Bore Damage
b - Scuffed Or Damaged Skirt
c - Eroded Areas

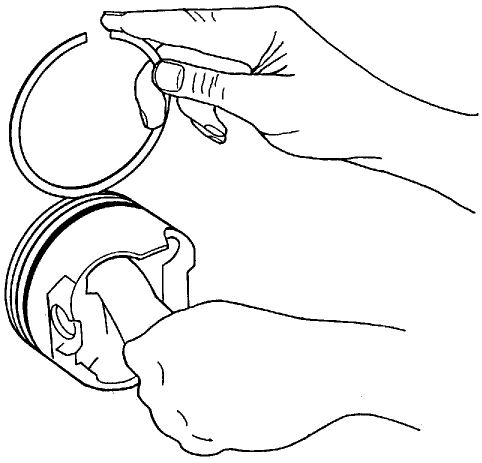
6. Measure piston skirt and check clearance.



76760

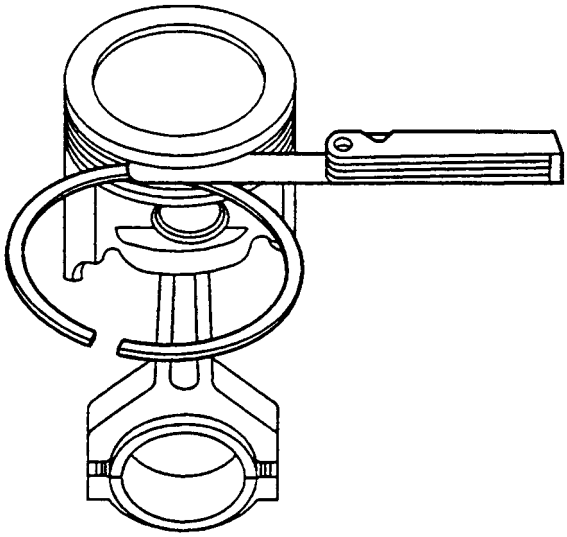
a - Micrometer
b - Piston Skirt

7. Slip outer surface of a new top and second compression ring into respective piston ring groove and roll ring entirely around the groove to verify that ring is free. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.



72366

8. Proper clearance of piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured.



76759

PISTON PINS

1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately. Piston pins are not removable.

Reassembly

IMPORTANT: Reassembly of pistons and connecting rods require adherence to the following steps.

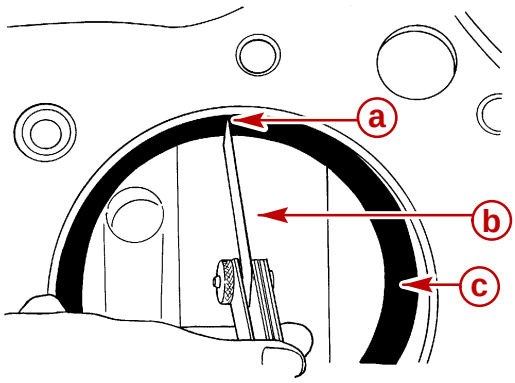
- Piston and pins are not removable.
- If original piston assemblies are being used, reinstall in same cylinder from which they were removed.
- Connecting rod bearing tangs are always toward outside of cylinder block.
- Notch or relief valve in piston must be positioned correctly for the engine being repaired.

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, ensure that marked side is toward top of piston.

Oil rings consist of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4 in. (6 mm) below ring travel. Be sure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge as shown.



72372

a - Gap
b - Feeler Gauges
c - Compression Ring

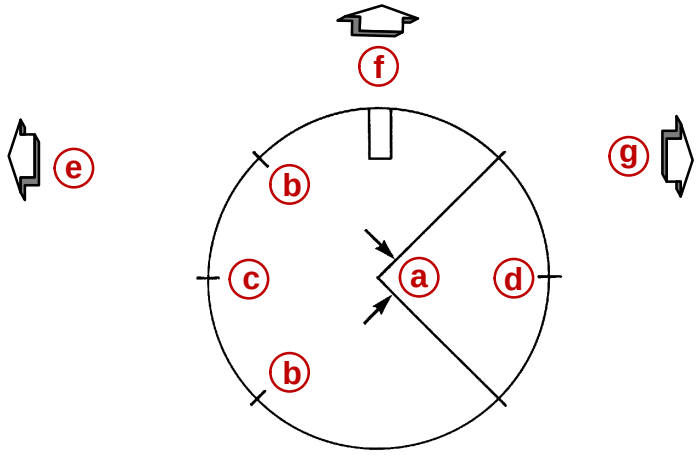
4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons.
7. Install piston rings as follows:
   a. Install oil ring spacer in groove and insert anti–rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to verify ring is free. If binding occurs at any point, the cause should be determined and, if caused by ring groove, removed by dressing groove with a fine cut file. If binding is caused by a distorted ring, use anew ring.

IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.

e. Install lower compression ring with marked side up, using ring expander.

f. Install top compression ring with marked side up, using ring expander.

IMPORTANT: Ensure ring gaps are properly positioned as shown.



72373

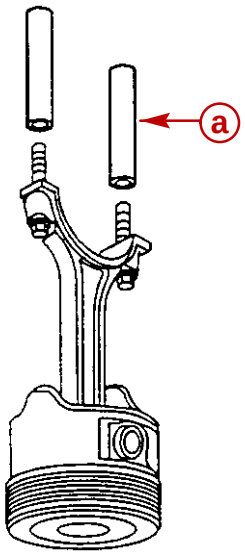
Ring Gap Location

a - Oil Ring Spacer Gap (Tang In Hole Or Slot Within Arc)
b - Oil Ring Gaps
c - 2nd Compression Ring Gap
d - Top Compression Ring Gap
e - Port Side
f - Engine Front
g - Starboard Side

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and clean cloth, then wipe with a clean, dry cloth.

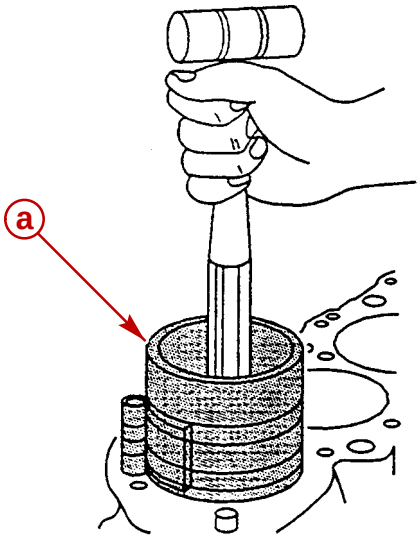
1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install connecting rod bolt guide on connecting rod bolts.



76719

a - Connecting Rod Bolt Guide

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. Use piston ring compressor to compress rings. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

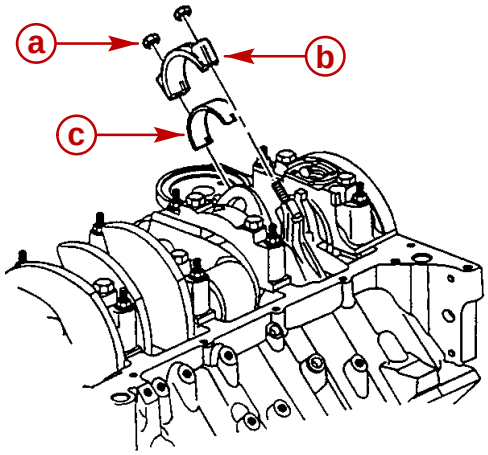


76792

a - Piston Ring Compressor (J-8037)

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5, and 7 in left bank and 2, 4, 6, and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.

5. Remove connecting rod bolt guide.
6. Install bearing caps and evenly torque nuts.



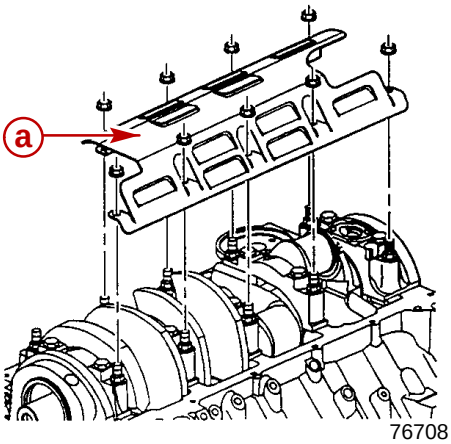
76716

a - Connecting Rod Nuts
b - Connecting Rod Caps
c - Lower Bearing

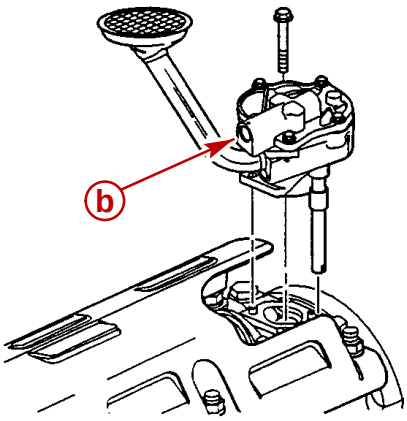
7. Check connecting rod side clearance as previously described.

NOTE: *If bearing replacement is required, refer to "Connecting Rod bearings."*

8. Install oil pump and crankshaft oil deflector.



76708



76707

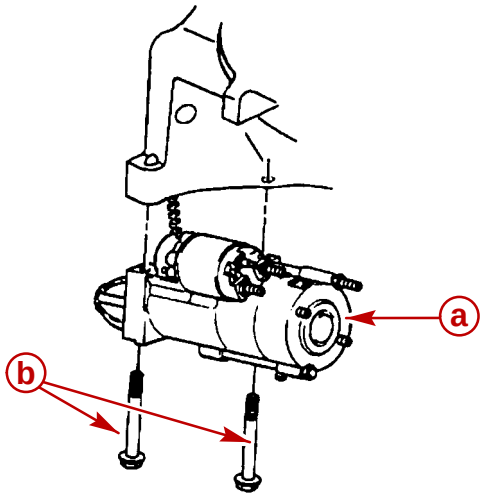
a - Crankshaft Oil Deflector
b - Oil Pump

9. Install oil pan and dipstick tube.
10. Install cylinder heads.
11. Install intake manifold.
12. Install all other components removed.
13. Fill cooling system.
14. Fill crankcase with oil.

Crankshaft

Removal

1. Remove drive unit from engine.
2. Remove engine from boat.
3. Remove transmission.
4. Drain crankcase oil.
5. Remove starter.

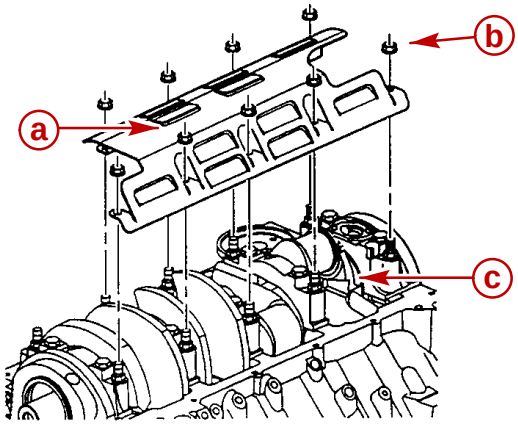


76489

a - Starter
b - Bolts

6. Remove flywheel housing.
7. Remove coupler/drive plate.
8. Remove flywheel.
9. Remove belt.
10. Remove water circulating pump.
11. Remove crankshaft pulley and torsional damper.
12. Remove oil pan and dipstick tube.
13. Remove oil pump.

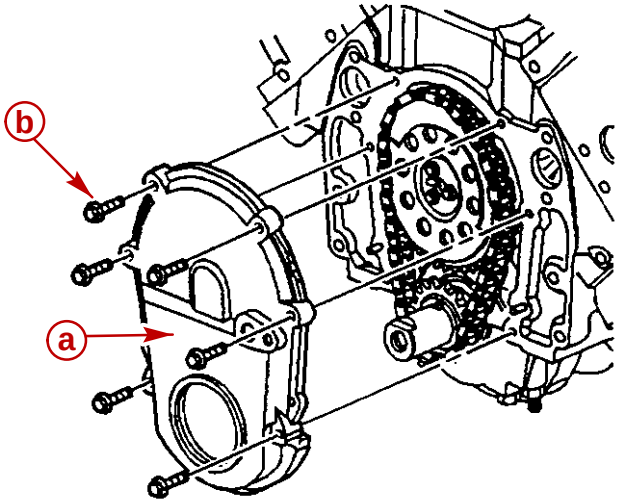
14. Remove crankshaft oil deflector.



76708

a - Crankshaft Oil Deflector
b - Nuts (9)
c - Crankshaft

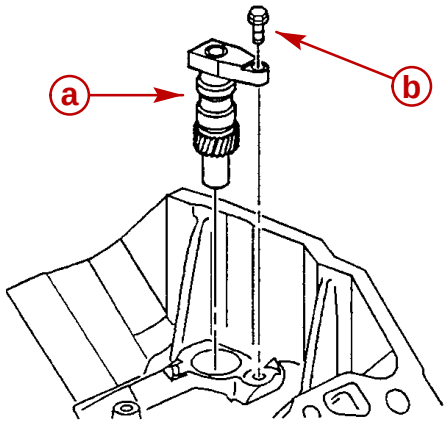
15. Remove front cover.



76710

a - Front Cover
b - Screws (6)

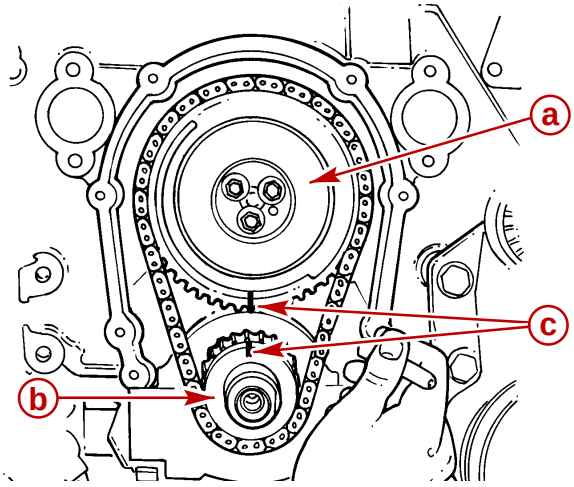
16. Remove oil pump drive.



76704

a - Oil Pump Drive
b - Screw

17. Turn crankshaft to align timing mark with camshaft mark or mark both gears for alignment in reassembly.

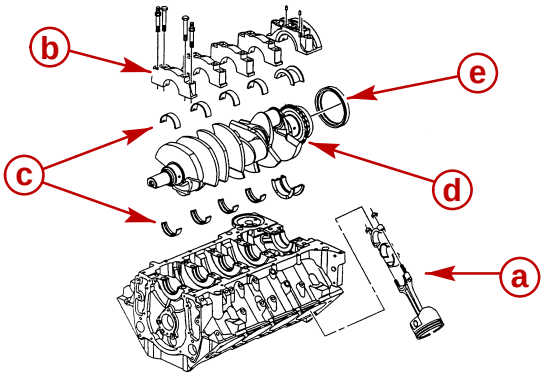


77478

a - Camshaft Gear
b - Crankshaft Gear
c - Alignment Marks

18. Remove camshaft gear.
19. Remove timing chain.
20. Remove rear main seal.

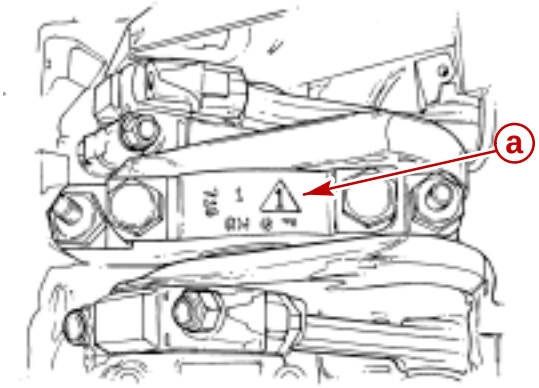
IMPORTANT: Inspect bearing caps for orientation marks prior to removal. If no markings exist, make suitable marks before disassembly so that they can be reinstalled in their original locations.



76682

a - Piston And Rod Assemblies
b - Bearing Caps
c - Main Bearings
d - Crankshaft
e - Rear Main Seal

21. Ensure all bearing caps are marked for reinstallation in their original locations.

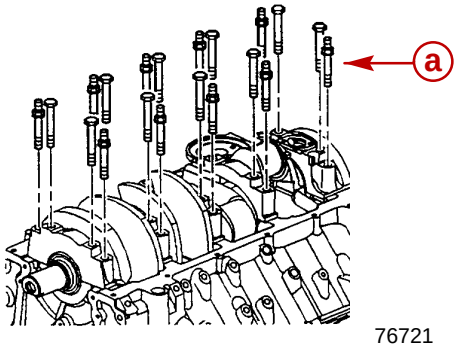


77467

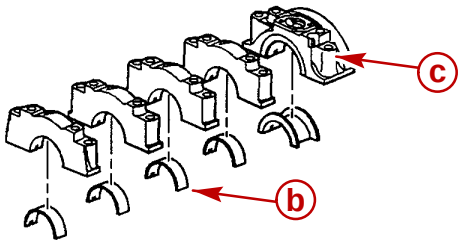
a - Bearing Cap Marking

22. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.

23. Remove main bearing caps fasteners and main bearing caps.



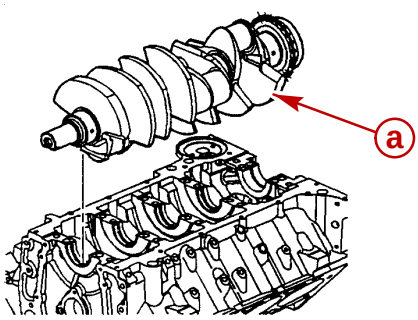
76721



76722

a - Main Bearing Cap Fasteners
b - Main Bearings
c - Main Bearing Caps

24. Carefully remove crankshaft.



76723

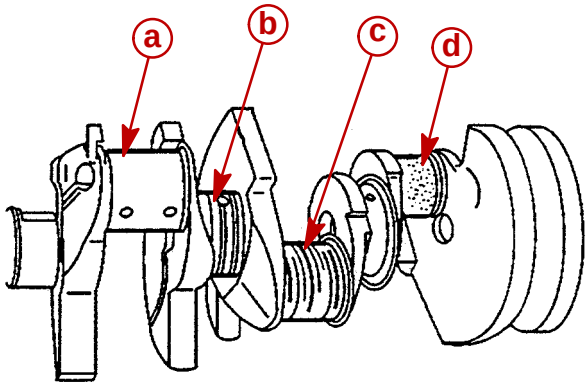
a - Crankshaft

25. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings.

Cleaning and Inspection

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals with a micrometer for out-of-round, taper or undersize.

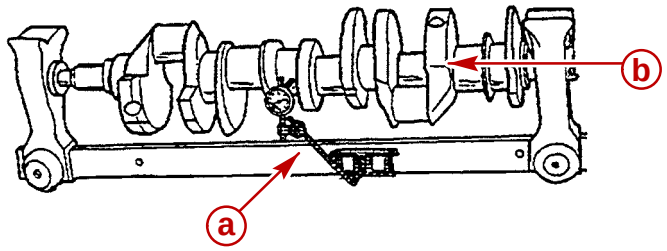
3. Inspect crankshaft.



76741

a - Smooth Surface
b - Grooves
c - Scratches Or Uneven Surface
d - Pitted Surface

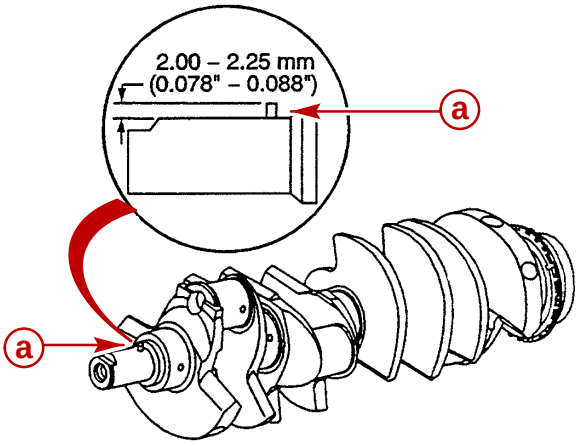
4. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check at front and rear intermediate journals with a dial indicator.



76744

a - Dial Indicator (J-7872)
b - Crankshaft

5. Inspect crankshaft pin for wear or damage.



76742

a - Crankshaft Pin

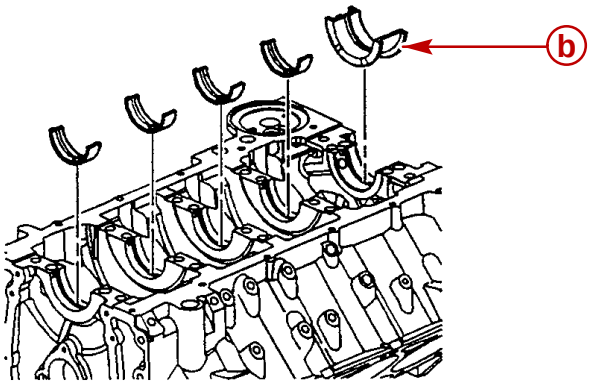
6. Replace or recondition crankshaft if not within specifications.

Installation

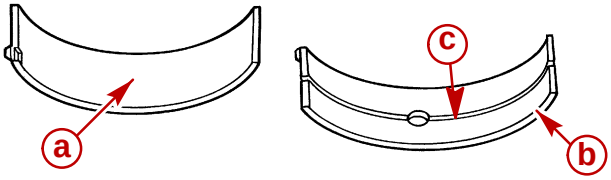
1. Remove timing gear from old crankshaft and reinstall on new crankshaft.

IMPORTANT: Verify that all bearings and crankshaft journals are clean.

2. Install main bearings in engine block.



76724

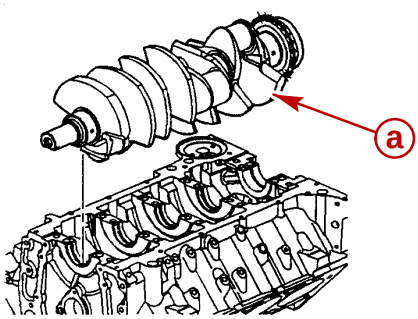


72359

Main Bearing Inserts

a - Lower Bearing Insert (Install In Cap)
b - Upper Bearing Insert (Install In Block)
c - Oil Groove

3. Carefully lower crankshaft into place. Be careful not to damage bearing surface.

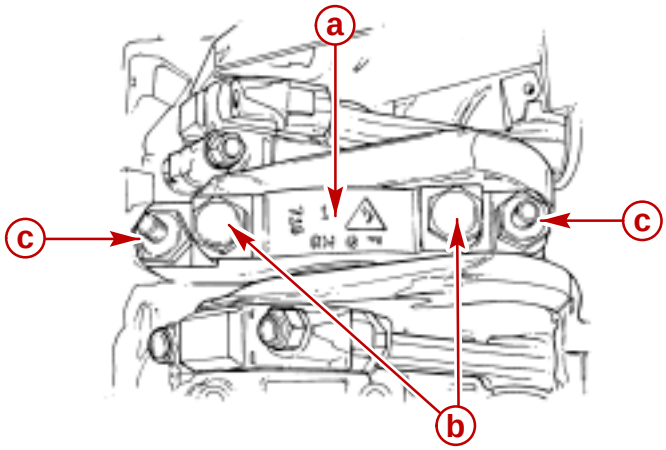


76723

a - Crankshaft

4. Check clearance of each main bearing, following procedure outlined under “Main Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
5. Using new bearing cap screws and studs, install main bearing caps.

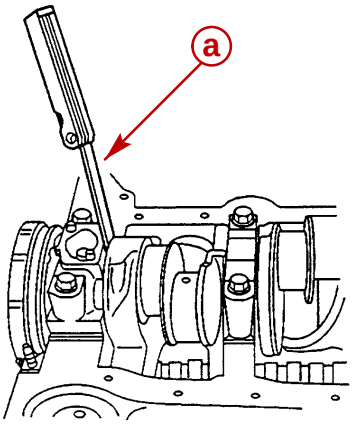
6. Torque main bearing caps as follows:
   a. Inner bearing cap bolts to 22 ft-lbs. (30 Nm).
   b. Outer bearing cap studs to 22 ft-lbs. (30 Nm).
   c. Inner bearing cap bolts an additional 90 degrees.
   d. Outer bearing cap studs an additional 80 degrees.



77467

a - Main Bearing Cap
b - Inner Bolts
c - Outer Studs

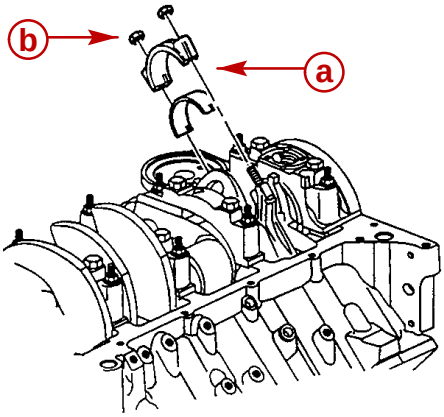
7. Check crankshaft end play. Proper clearance is .005-.011 in. (.127-.279 mm).



76754

a - Feeler Gauge

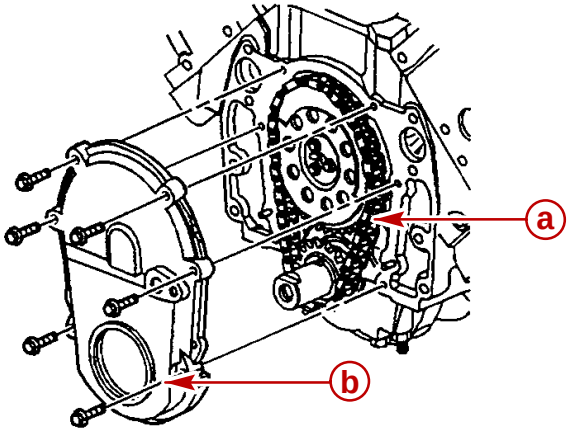
8. Check clearance for each connecting rod bearing, following procedure under “Connecting Rod Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
9. Install rod caps and evenly torque nuts. New nuts must be used to achieve proper torque.



76716

a - Connecting Rod Caps
b - Nuts

10. Turn crankshaft so mark on timing gear is facing camshaft.
11. Install timing chain and gear on camshaft and align marks with crankshaft.
12. Install front cover.



76710

a - Timing Chain
b - Front Cover

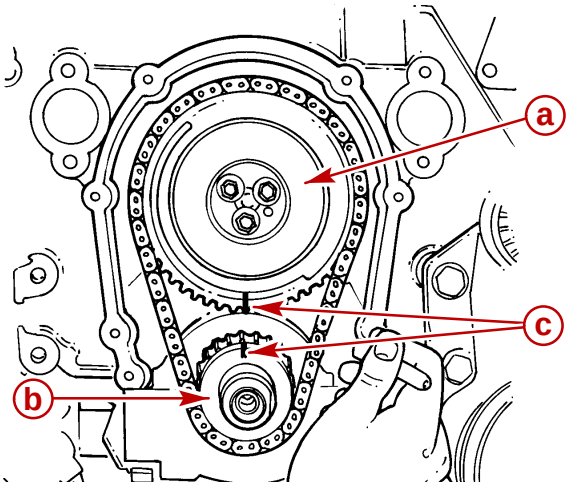
13. Install oil pump and crankshaft oil deflector.
14. Install dipstick tube and oil pan.
15. Install torsional damper and crankshaft pulley.
16. Install water circulating pump.
17. Install serpentine belt.
18. Install flywheel and drive coupler/plate.
19. Install flywheel housing.
20. Install starter.

21. Install new oil filter.
22. Fill crankcase with oil.
23. Fill closed cooling system and supply a sufficient water supply to the engine.
24. Start engine and check for leaks..

Timing Chain and Sprocket

Removal

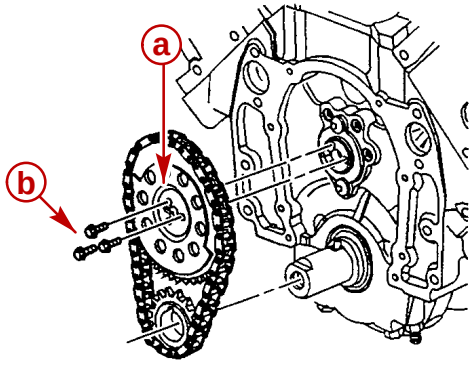
1. Remove torsional damper and front cover.
2. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment or mark both sprockets for alignment reassembly.



77478

a - Camshaft Gear
b - Crankshaft Gear
c - Alignment Marks

3. Remove camshaft sprocket and timing chain. If sprocket does not come off easily, a light tap on the lower edge of the sprocket with a plastic mallet should dislodge it.



76711

a - Camshaft Gear
b - Fasteners

4. Remove crankshaft sprocket if it requires replacement.

Cleaning and Inspection

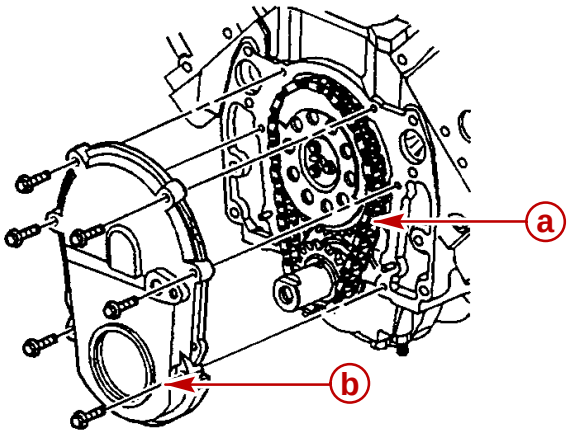
1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear and damage.
3. Inspect sprockets for wear and damage.

Installation

1. Install crankshaft sprocket.
2. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down. Align marks on camshaft and crankshaft sprockets.

IMPORTANT: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

3. Install sprocket on camshaft. Torque bolts to 22 lb-ft (30 Nm).
4. Lubricate timing chain with engine oil.
5. Install front cover.



76710

a - Timing Chain
b - Front Cover

6. Install torsional damper.
7. Reinstall any other components removed in repair process.

Crankshaft Sprocket

Removal

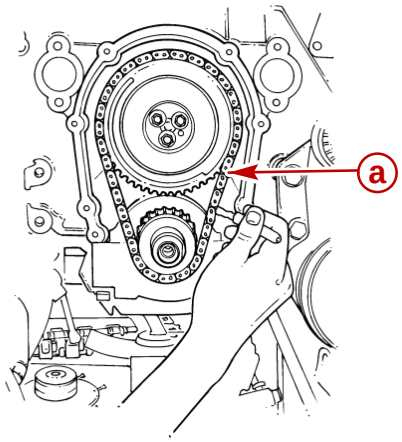
1. Remove torsional damper and front cover.
2. Remove camshaft gear and timing chain.
3. Remove crankshaft sprocket using crankshaft gear puller (J-42846).

Installation

1. Using crankshaft gear and sprocket installer, install sprocket on crankshaft.
2. Install timing chain.

Checking Timing Chain Deflection

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
4. The deflection is the difference between these two measurements. If the deflection exceeds 3/4 in. (19 mm), timing chain should be replaced.



77478

a - Timing Chain

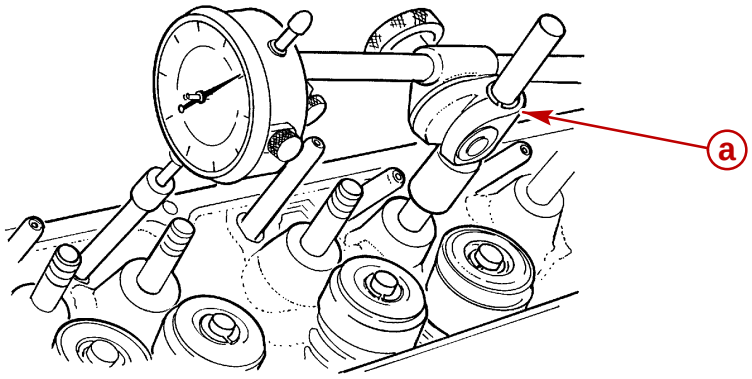
5. Install front cover.
6. Install torsional damper.

Camshaft

Measuring Lobe Lift

NOTE: *Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.*

1. Remove valve mechanism.
2. Adapt dial indicator to cylinder head by temporarily installing suitable stud in bolt hole. Position indicator with ball socket adaptor tool, from Lift Indicator Tool Kit, on push rod. Ensure that push rod is in lifter socket.



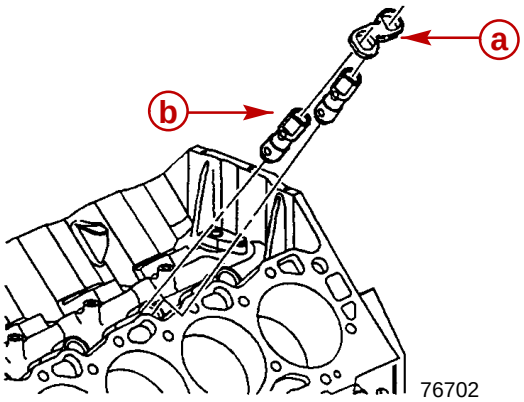
72380

a - Ball Socket Adapter Tool (J-8520-1)

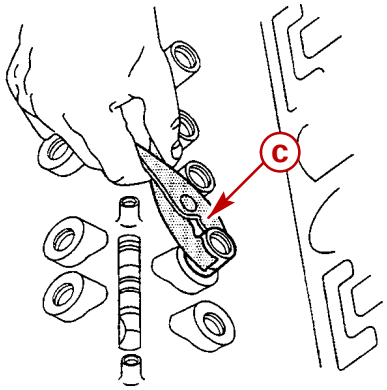
3. Rotate torsional damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate torsional damper slowly (or attach an auxiliary starter switch and “bump” engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with “Specifications.”
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly and hardware.
8. Install and torque valve mechanism.

Camshaft Removal

1. Remove valve lifters. Valve lifter removal tool can be used to ease removal.



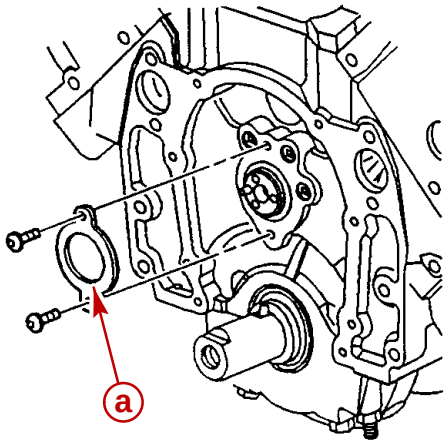
76702



76703

a - Valve Lifter Restrictor
b - Valve Lifter
c - Valve Lifter Removal Tool (J3049-A)

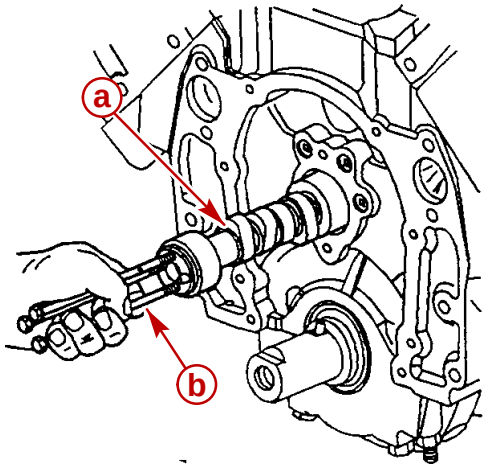
2. Remove front cover.
3. Remove timing chain and gear.
4. Remove camshaft retainer.



76713

a - Camshaft Retainer

5. Install three 5/16-18 x 5 in. bolts in camshaft bolt holes and carefully remove camshaft.

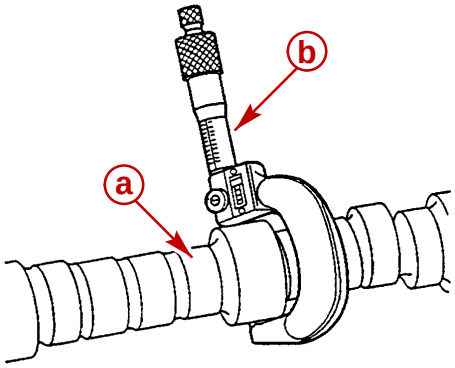


76714

a - Camshaft
b - 5/16-18 x 5 in. Bolts

Inspection

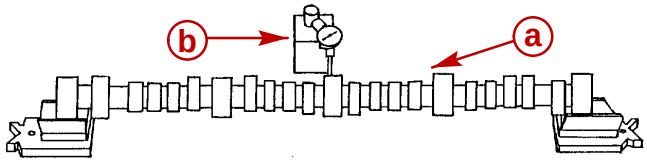
Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001 in. (0.025 mm) out-of-round, camshaft should be replaced.



76766

a - Camshaft
b - Micrometer

Also check camshaft for alignment with V-blocks and dial indicator which indicates exact amount camshaft is out of true. If out more than .002 in. (0.051 mm) (dial indicator reading) camshaft should be replaced.

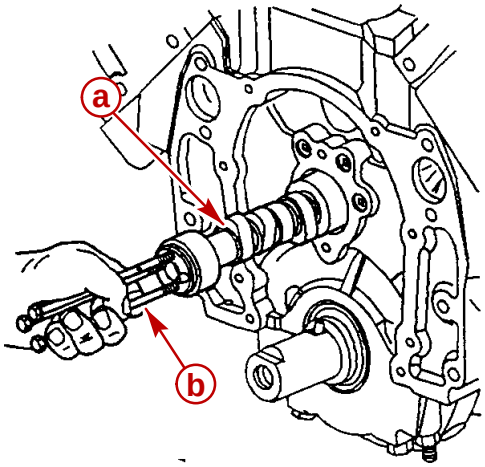


72382

a - Camshaft
b - Dial Indicator

Installation

1. Install three 5/16-18 x 5 in. bolts in camshaft bolt holes, then lubricate camshaft bearing journals with engine oil.



76714

a - Camshaft
b - 5/16-18 x 5 in. Bolts

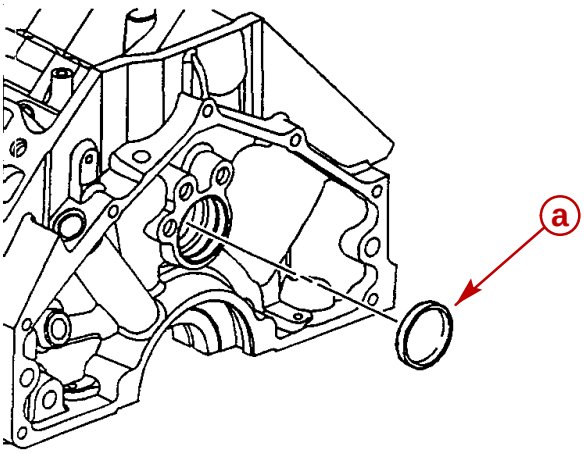
2. Lubricate camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.
3. Install camshaft. Be careful not to damage bearings.
4. Install camshaft retainer.
5. Install timing chain.
6. Install front cover, valve lifters, lifter restrictors and lifter restrictor retainer.
7. Install all other components removed in the repair process.
8. Fill crankcase oil.
9. Fill closed cooling system.
10. Supply a sufficient water supply to the engine.
11. Start engine and check for leaks.

Camshaft Bearings

Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings. Remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place.

1. Remove crankshaft and camshaft.
2. Drive camshaft rear plug from cylinder block.



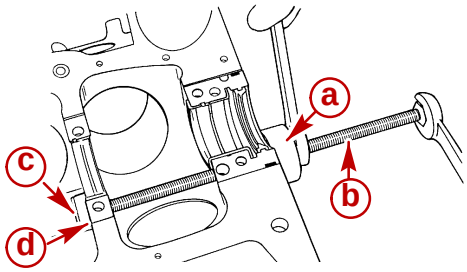
76726

a - Camshaft Rear Plug

NOTE: *This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of turns to remove all bearings.*

3. Install nut and thrust washer to end of threads on camshaft bearing remover and installer set (J-33049).
4. Position pilot in front camshaft bearing.
5. Install puller screw through pilot.
6. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
7. Using two wrenches, hold puller screw while turning nut.
8. Pull bearing bore.
9. Remove tool and bearing from puller screw.
10. Remove remaining bearings (except front and rear) in same manner.

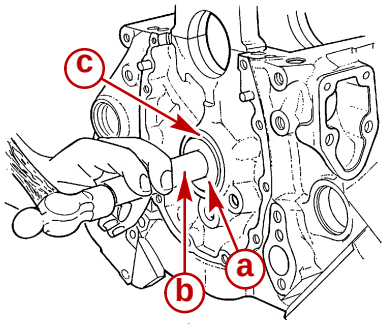
11. Position pilot in rear camshaft bearing to remove rear intermediate bearing.



72383

a - Index Pilot
b - Puller Screw
c - Driver
d - Bearing

12. Assemble driver on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



72384

a - Driver
b - Driver Handle
c - Bearing

Cleaning and Inspection

1. Clean camshaft bearing bores in cylinder block with solvent and dry with compressed air.
2. Ensure that grooves and drilled oil passages are clean.

Installation

IMPORTANT: Front and rear bearings must be installed last as pilot will not fit into bearing bores if bearings are installed.

NOTE: *Lubricate outer surface of new camshaft bearings with engine oil to ease installation.*

INDEXING BEARING

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and to position bearings as follows (directional references are in reference to engine in its normal operating position):

- **Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.**

INTERMEDIATE AND CENTER BEARINGS

1. Install nut and thrust washer onto puller screw.
2. Position pilot in front camshaft bearing bore and insert screw through pilot.
3. Index center camshaft bearing.
4. Position appropriate size removal and installation tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.
5. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position.
6. Remove the removal and installation tool and ensure that oil hole(s) in bearing are positioned correctly.
7. Install intermediate bearings in same manner. Ensure bearings are indexed correctly. Position pilot in rear camshaft bearing bore to install rear intermediate bearing.

FRONT AND REAR BEARINGS

1. Install appropriate size removal and installation tool on drive handle.
2. Index front bearing and drive it into position with tool.
3. Ensure bearing is positioned correctly. Index rear bearing and drive it into position with tool.
4. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32 in. (0.8 mm) deep and must be parallel with rear surface of cylinder block.

5. Install crankshaft and camshaft.

NOTE: *This procedure is based on removal of bearings from center of engine first.*

6. Using camshaft bearing remover and installer set (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.

Cylinder Block

Cleaning

1. Remove all engine components.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.
4. Remove expansion plugs.

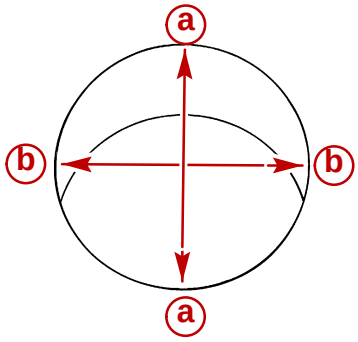
NOTE: *These plugs may be removed with a sharp punch, or they may be drilled and pried out.*

5. Clean water passages in cylinder block.

Inspection

1. Inspect water passages in cylinder block.
2. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.

3. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



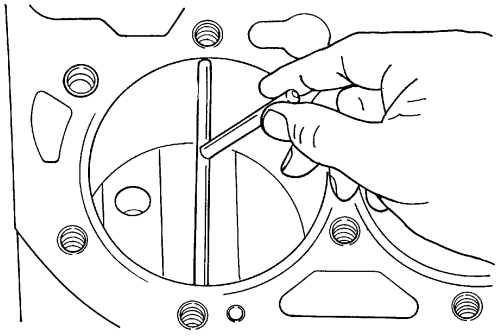
72385

Cylinder Measurement

a - At Right Angle To Centerline Of Engine
b - Parallel to Centerline Of Engine

"Out Of Round" Equals The Difference Between "a" and "b"

Measurement At Top Of Cylinder Bore and
Measurement At Bottom Of Cylinder Bore



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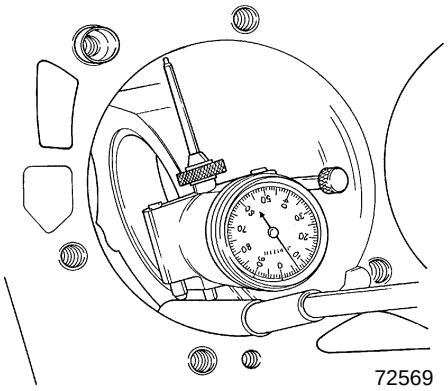
Telescope Gauge



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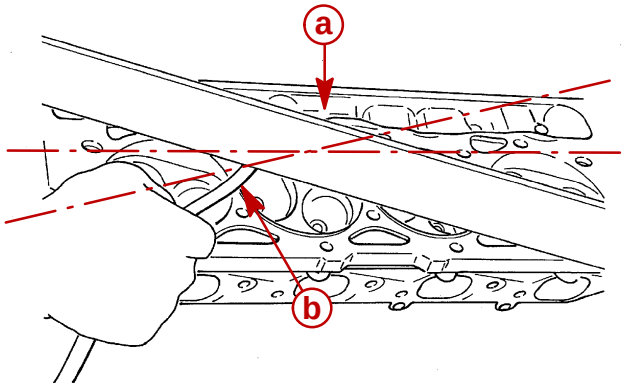
Dial Indicator

4. Check cylinder head gasket surfaces for warpage with a machinist's straight-edge and a feeler gauge, as shown. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than .003 in. (0.07 mm) in a 6 in. area or .007 in. (0.17 mm) overall, block must be resurfaced by an automotive machine shop.



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a - Machinist's Straight Edge
b - Feeler Gauge

CYLINDER CONDITIONING

1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005 in. (0.127 mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than .005 in. wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If more than .005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER HONING

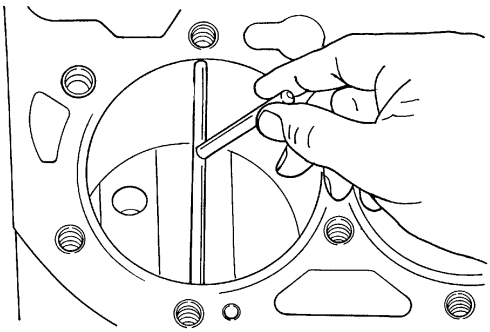
1. Follow hone manufacturer's recommendations for use of hone.
2. Several times, during the honing operation, clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size.

5. Clean cylinder bores with hot water and detergent. Scrub with a stiff bristle brush and completely rinse with hot water. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinders should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure cylinder bore diameter with a telescope gauge 2-1/2 in. (64 mm) from top of cylinder bore as follows.



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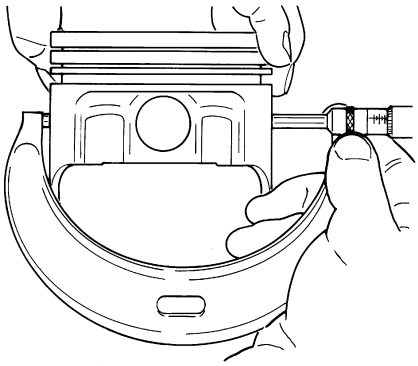
   b. Measure piston diameter at skirt across centerline of piston pin.



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   c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
   d. Determine if piston-to-bore clearance is in acceptable range shown in “Specifications.”
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.

Compression Test

NOTE: *Compression pressure is 100 psi (690 kPa) minimum. Minimum compression recorded in any one cylinder should not be less than 70% of the highest recorded cylinder.*

1. Disable ignition system and remove all spark plugs.

NOTE: *Use a fully charged battery when performing the following procedure.*

2. Open throttle plate completely.
3. Starting with the compression gauge at “0,” crank the engine through 4 compression strokes (4 puffs).
4. Record compression for each cylinder.
5. If some cylinders have low compression, use a pump type oil can to inject 3 squirts of oil into each combustion chamber through the spark plug hole. Do a second compression check on each cylinder.
6. No cylinder should read less than 100 psi (690 kPa). Compression recorded on any one cylinder should not be less than 70% of the highest cylinder.
7. 4 characteristics may be evident:
   - Normal: Compression builds up quickly and evenly in each cylinder.
   - Piston Rings Leaking: Compression low on first stroke then increases on following strokes, but does not reach normal. Compression improves considerably with 3 squirts of oil.
   - Valves Leaking: Compression low on first stroke and does not build up on following strokes or with 3 squirts of oil.
   - If 2 Adjacent Cylinders Have Lower Than Normal Compression: Inject 3 squirts of oil into the cylinders. If the compression does not increase, the cause may be a blown head gasket between cylinders.

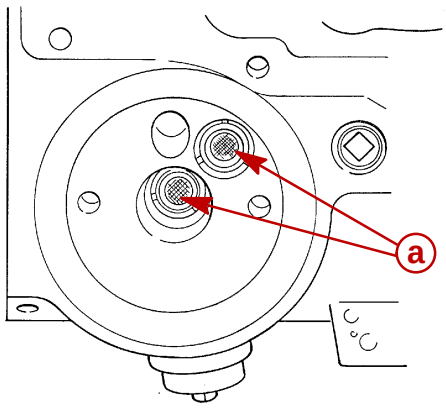
Oil Filter By-Pass Valves and Adaptor

Inspection and / or Replacement

Oil by-pass valve and adaptor should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

Refer to “Engine Parts List” when ordering parts for oil filter by-pass valve, adaptor assembly or remote oil filter parts.

1. Remove oil hoses from adaptor.
2. Remove hose fitting and seal from adaptor.
3. Remove connector.
4. Clean parts in solvent and blow dry with compressed air.
5. Inspect fiber valves for cracks or other damage. Check that valves fit tightly against seats. Push each valve down and release it. Valves should return freely to their seats. If valve operation is questionable, by-pass valve should be replaced.



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Typical By-Pass Valve and Adaptor

a - Fiber Valves (Ensure That Valves Fit Tightly Against Their Seals)

6. Wipe out valve chamber in cylinder block to remove any foreign material.
7. Install by-pass valve (if replaced) and connector. Torque adaptor nut to 20 lb-ft (27 Nm).
8. Lubricate adaptor seal with engine oil. Install hose fitting and torque to specifications.
9. Apply Perfect Seal to hose threads. Install and tighten securely.

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ELECTRICAL SYSTEMS

Section 4A - Starting System

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A

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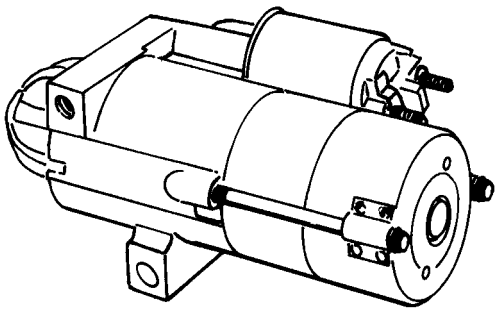
Delco PG260 Starter Motor

Identification



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Delco PG260 Starter Motor

Starter Specifications

Delco I.D. Number	MerCruiser Part Number
9000821	50-806964

Engine Rotation	No Load Test					Brush Spring Tension Oz. (Grams)
	Volts	Min. Amps	Max. Amps	Min. RPM	Max. RPM	
LH	10.6	60	95	2750	3250	83-104 (2352-2948)
Pinion Clearance	.101-.160 in. (.025-4.06 mm)					
Bearing Depth (Gear)	.014 in. (.038 mm) Maximum					
Bearing Depth (Housing)	.017 in. (0.4 mm) Maximum					

Torque Specifications

Description	lb-in.	lb-ft	Nm
Starter Motor To Block		30	41
All Other Fasteners		Tighten Securely	

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3

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Starter Removal

⚠ WARNING

Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.
3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

Solenoid Switch

The solenoid switch can be removed and replaced if defective.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Ensure that starter mounting bolts are tight.

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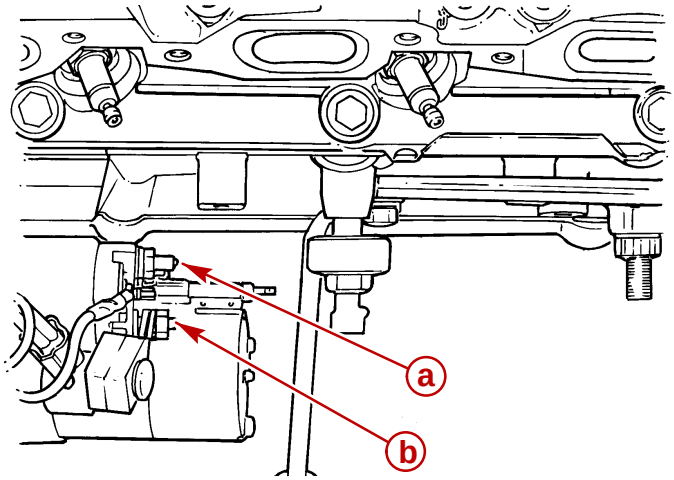
Installation

IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb-ft (41 Nm).
2. Connect YELLOW/RED wire to the upper solenoid terminal. Connect ORANGE wire, RED wire, and battery cable to the lower solenoid terminal. Tighten fasteners securely. Coat terminals with Quicksilver Liquid Neoprene. Install battery cable boot, if equipped.



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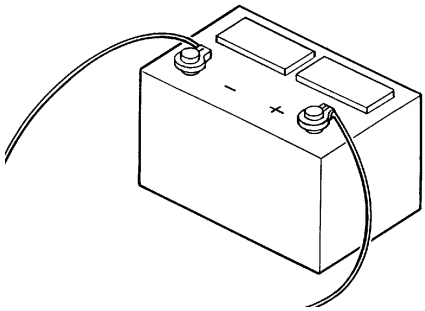
a - Upper Solenoid Terminal
b - Lower Solenoid Terminal

3. Connect battery cables to battery in the following order. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.



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ELECTRICAL SYSTEM

Section 4B - Ignition System

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Spark Plug Wires 4B-5

4
B

Specifications

Description	Specification
Firing Order	1-8-7-2-6-5-4-3
Spark Plug Type	Denso TJ14R-P15
Spark Plug Gap	0.060 in. (1.52 mm)

Torque Specifications

Description	lb-in.	lb-ft	Nm
New Spark Plugs		22	30
Old Spark Plugs		15	20

Tools

Description	Part Number
Multi-Meter / DVA Tester	91-99750A1

Lubricants / Sealants / Adhesives

Description	Part Number
Silicone Dielectric Compound	92-802882A1
Heat Transfer Compound	92-805701--1

Ignition Control System Components

EFI System Maintenance Precautions

⚠ WARNING

Avoid Injury or Electrical System Damage: Always disconnect battery cables from battery before working around electrical system components.

⚠ CAUTION

Avoid damage to the EFI electrical system components: Refer to the following precautions when working on or around the EFI electrical harness, or when adding other electrical accessories:

- **DO NOT tap accessories into engine harness.**
- **DO NOT puncture wires for testing (Probing).**
- **DO NOT reverse battery leads.**
- **DO NOT splice wires into harness.**
- **DO NOT attempt diagnostics without proper, approved Service Tools.**

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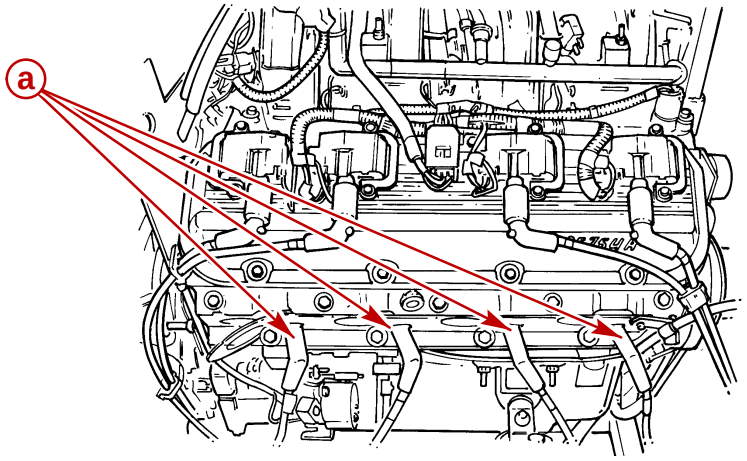
Spark Plugs

CHECKING

1. Disconnect spark plug wires (high tension leads) from spark plugs.



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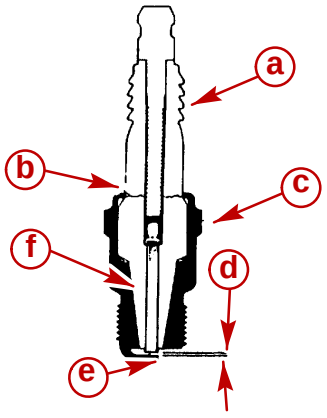
Exhaust Manifold Removed For Visual Clarity

a - Spark Plugs

NOTE: *Use care when removing spark plug wires from spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire from the spark plug..*

2. Remove spark plugs.
3. Ensure that all spark plugs are from the same manufacturer and have the same spark plug number.
4. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.

NOTE: *Cracks often occur at the base of the insulator.*



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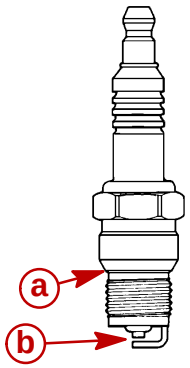
a - Porcelain Insulator
b - Insulator Base
c - Shell
d - Proper Gap
e - Side Electrode
f - Center Electrode

REPLACING

1. Clean the plug seating area on the cylinder heads and spark plugs.

IMPORTANT: When adjusting gap, DO NOT bend center electrode.

2. Adjust spark plug gap with a round feeler gauge. Bend side electrode to adjust gap.



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a - Seating Area
b - Gap

IMPORTANT: Spark plugs should be torqued to the amount specified. If they cannot be torqued, the spark plugs should be hand tightened until the plug contacts the cylinder head. Then, using an appropriate wrench and socket, slightly rotate (approximately 1/8 or less of a full turn) to create a seal and secure the plug.

3. Install spark plugs and torque to specifications.
4. Install spark plug wires in proper order.

Spark Plug Wires

CHECKING

1. Inspect spark plug wires for damage, such as being cracked, cut or oil soaked.
2. Inspect spark plug boots for damage.
3. Check spark plug wires for continuity using a Multi-Meter, Digital/Volt/Ohm Meter, or similar. Replace any plug wires that do not show continuity from end to end.
4. Replace any damaged plug wires.

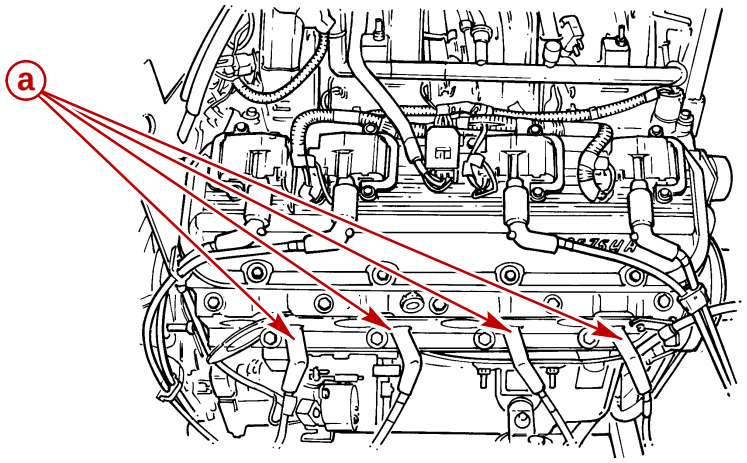
REPLACING

IMPORTANT: Use only spark plug wires recommended for Marine application.

NOTE: *Replace one wire at a time to reduce the risk of error.*

1. Disconnect individual spark plug wires.

NOTE: *Use care when removing spark plug wires from spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the* ***boot*** *to remove the wire from the spark plug..*



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Exhaust Manifold Removed For Visual Clarity

a - Spark Plug

2. Install new spark plug wires in proper order.

IMPORTANT: Wire routing must be kept intact during service and followed exactly when wires have been disconnected or when wire replacement is necessary. Failure to route wires properly can lead to radio frequency interference, cross firing of the plugs and/or shorting of leads to ground.

a. Position wires in spark plug wire supports and retainers.

b. Attach plug wires to appropriate spark plug and coil pack. Each end should fit securely.

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ELECTRICAL SYSTEM

Section 4C - Charging System

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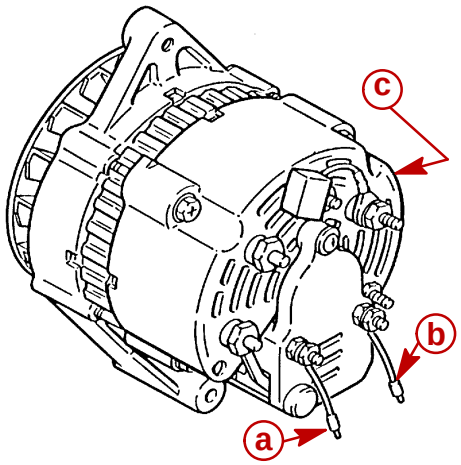
Delco Alternator

Identification



72078

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Part Number (Hidden In This View)

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your Mercury MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Specifications

Description	Specification
Excitation Circuit	1.3 to 2.5 Volts
Current Output	60 Amp. Min.
Voltage Output	13.9 to 14.7 Volts
Minimum Brush Length	1/4 in. (6 mm)

Torque Specifications

Description	lb-in.	lb-ft	Nm
Alternator to Mounting Bracket		35	48
Alternator Mounting Bracket		30	41
Belt Tension	See Note		

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Refer to Drive Belt Adjustment.*

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Tools

Description	Part Number
Multi-Meter / DVA Tester	91-99750A1
Ammeter (0-100 Amp)	Obtain Locally

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3

Precautions

The following precautions MUST BE observed when working on the charging system. Failure to observe these precautions may result in serious damage to the alternator or charging system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the Troubleshooting Tests.
3. NEVER disconnect the alternator output lead or battery cables when the alternator is operating.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is operating.
5. ALWAYS remove negative (–) battery cable from battery before working on the charging system.
6. When installing battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

EFI Electrical System Precautions

⚠ CAUTION

Avoid damage to the EFI electrical system and components. Refer to the following precautions when working on or around the EFI electrical harness or when adding other electrical accessories:

- **DO NOT tap accessories into engine harness.**
- **DO NOT puncture wires for testing (Probing).**
- **DO NOT reverse battery leads.**
- **DO NOT splice wires into harness.**
- **DO NOT attempt diagnostics without proper, approved Service Tools.**

Charging System Components

The alternator system consists of the alternator, battery, the ignition switch and the wiring that connects these components.

Periodic Maintenance

⚠ CAUTION

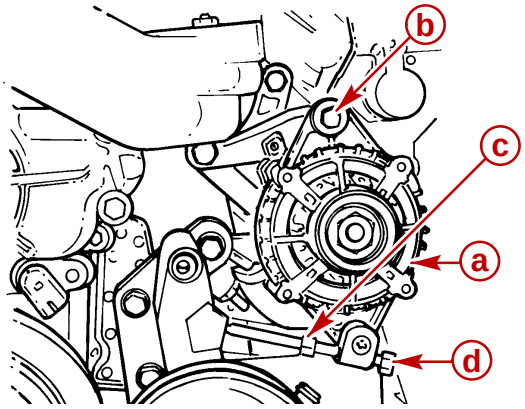
Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connectors.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under Drive Belt Adjustment.
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean or alternator may overheat.

Serpentine Drive Belt

Removal

1. Loosen alternator mounting bolt.
2. Loosen tension bolt retainer nut.
3. Loosen tension bolt.



77061

a - Alternator
b - Alternator Mounting Bolt
c - Retainer Nut
d - Tension Bolt

4. Move alternator to relieve tension on drive belt.

IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

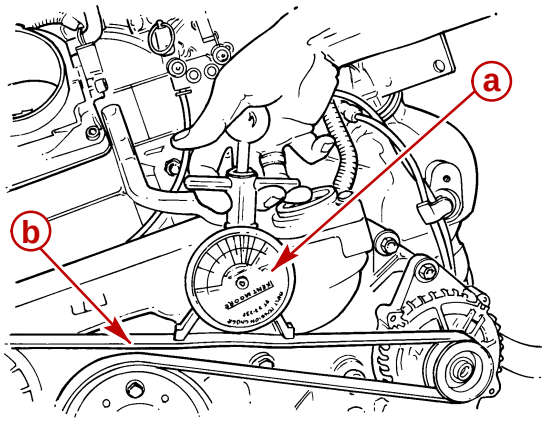
5. If belt is to be reused, mark direction of rotation.
6. Remove belt.

Installation And Adjustment

1. Install drive belt on pulleys.
2. Position tension bolt into idler pulley bracket.
3. Tighten tension bolt until belt is taut.

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys.*

4. Check belt deflection between the upper idler pulley and the alternator pulley using one of the following methods.
   a. Attach Kent Moore Belt Tension Gauge to belt. Gauge has different ranges for new and used belts.
   b. If tool is not available, belt deflection can be checked by applying moderate downward pressure on belt. Proper deflection is approximately 1/4 in. (6 mm).



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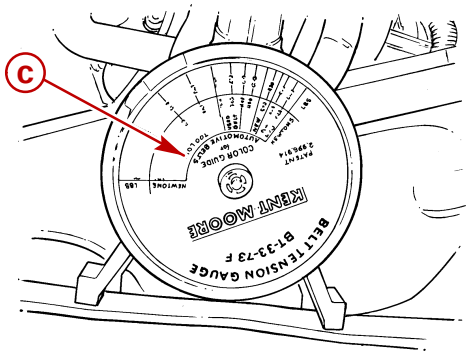

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a - Kent Moore Tension Gauge
b - Serpentine Belt
c - Dial Gauge On Belt Tension Tool

5. Securely tighten tension stud retainer nut.
6. Tighten alternator attaching bolt and nut.
7. Operate the engine for a short period of time. Recheck belt adjustment.

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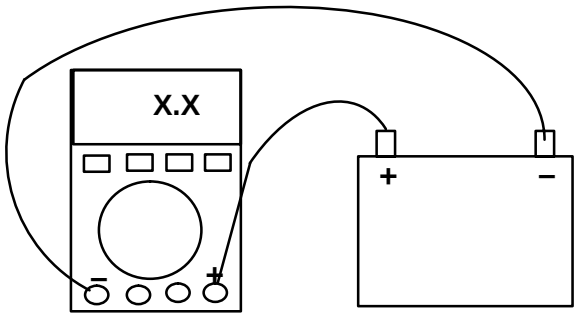
Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with SECTION 1 - Troubleshooting. Before proceeding with the tests, perform the following checks to eliminate possible problem areas. Also observe Precautions, preceding, to prevent damage to alternator system.

1. An undercharged battery can be caused by excessive current draw, from accessories or by operating the engine at low speeds for extended periods.
2. Check physical condition and battery charge. Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire charging system wiring for defects. Ensure all connections are secure and clean.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Replace if necessary. Also, check drive belt tension and adjust if necessary.

Charging System

1. Check belt condition and tension.
2. Check battery condition.



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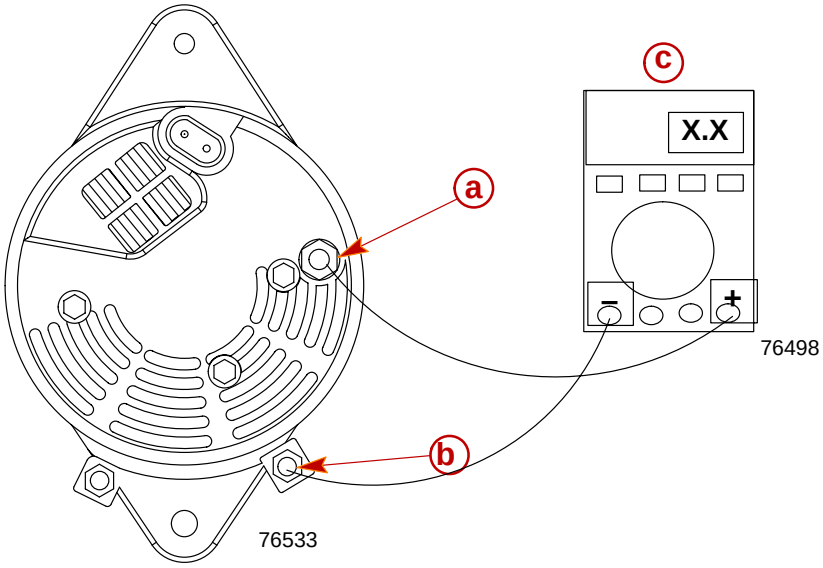
3. With a fully charged battery, connect voltmeter leads directly to the battery posts.
4. Start engine and run at 1300-1500 rpm. Read voltmeter in VDC position. Most systems will read 13.8-14.8 volts.

NOTE: *If the voltage reading is within specifications, switch voltmeter to AC volt position. There should not be more than a 0.250 AC voltage reading with the engine running. A reading more than 0.250 AC volts indicate defective diodes in the alternator.*

5. If the voltmeter reading at the battery posts is below 13.5 volts, connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (–) lead to the ground terminal on the alternator. Repeat step 4.



Typical

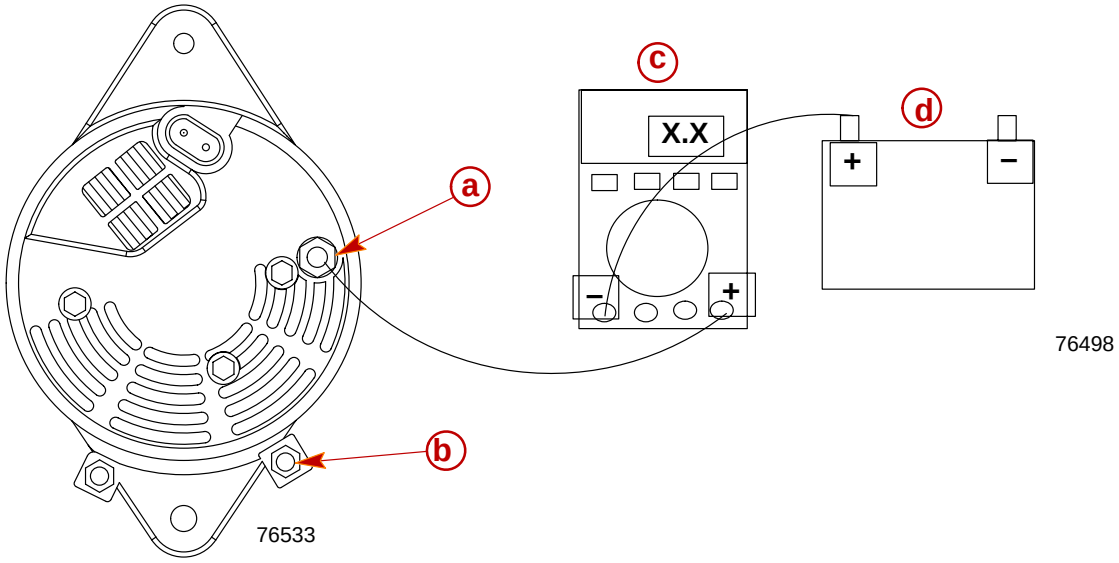
a - Output Terminal
b - Ground Terminal
c - Voltmeter

6. If voltmeter reading is now within specifications, there is too much resistance between the alternator and the battery.
7. If the reading is below 12.5 volts, the alternator may not be charging. Check all wiring leading to the alternator.

Charging System Resistance

1. Disconnect both coil pack wiring harness connections so that the engine does not start.
2. Crank engine over for 15 seconds to discharge the battery slightly.
3. Reconnect both coil pack wiring harness connections and turn off all accessories.
4. Connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (–) lead to the battery positive (+) post.

NOTE: *Connect voltmeter leads to the battery post, NOT the battery cable end.*

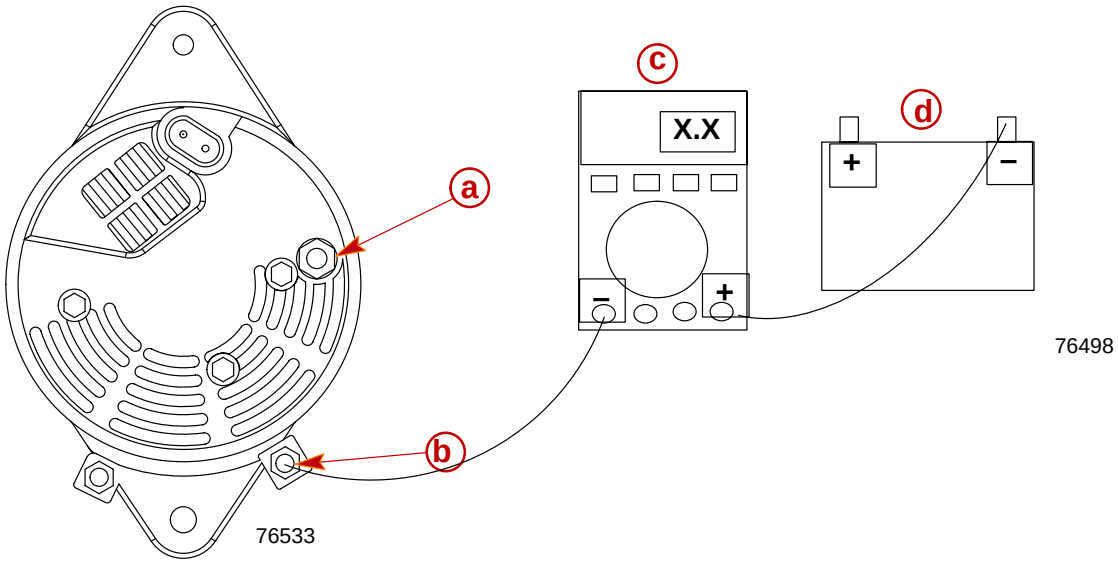


Typical

a - Output Terminal
b - Ground Terminal
c - Voltmeter
d - Battery

5. Start engine and run at 1300-1500 rpm. Read voltmeter. A reading of more than 0.5 volts shows excessive resistance in wiring.

6. Connect the voltmeter negative (–) lead to the alternator ground terminal. Connect voltmeter positive (+) lead to the battery negative (–) post.



Typical

a - Output Terminal
b - Ground Terminal
c - Voltmeter
d - Battery

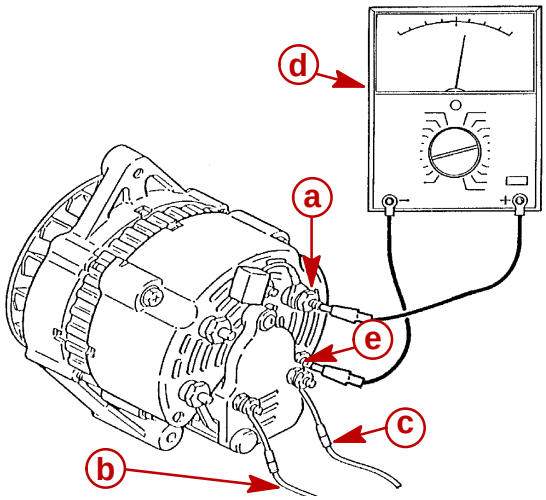
7. Repeat Step 5.

Circuitry

Perform the following tests, using a 0-20 volt DC voltmeter, to ensure that all of the circuits between the alternator and the other components within the charging system are in good condition.

OUTPUT CIRCUIT

1. Ensure battery is fully charged with the hydrometer test.
2. Start engine and increase RPM to approximately 1500 rpm.
3. Check voltage reading. The voltage should read between 13.8 and 14.2 volts. If the reading is below 13.8 volts:
   a. Connect positive (+) voltmeter lead to alternator output post.
   b. Connect negative (–) lead to ground post on alternator.
   c. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximate battery voltage and should not vary. If no reading is obtained, or if reading varies, Resistance in this section.



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Typical

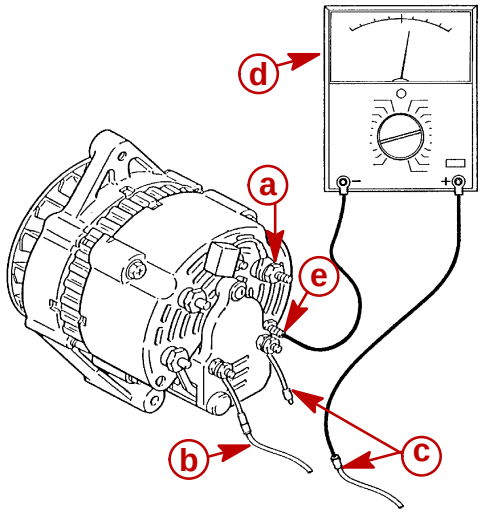
a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

EXCITATION CIRCUIT

1. Connect positive (+) voltmeter lead to tie strap terminal on alternator and negative (–) lead to a ground terminal on alternator (Test 1).
2. Turn ignition switch to ON position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
3. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug PURPLE lead from regulator. Connect positive voltmeter lead to PURPLE lead and negative voltmeter leads to ground (Test 2). If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.

SENSING CIRCUIT

1. Unplug RED/PURPLE lead from voltage regulator.
2. Connect positive (+) voltmeter lead to red/purple lead and negative (–) voltmeter lead to ground terminal.
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/purple lead) for loose or dirty connection or damaged wiring.



72786

Typical

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

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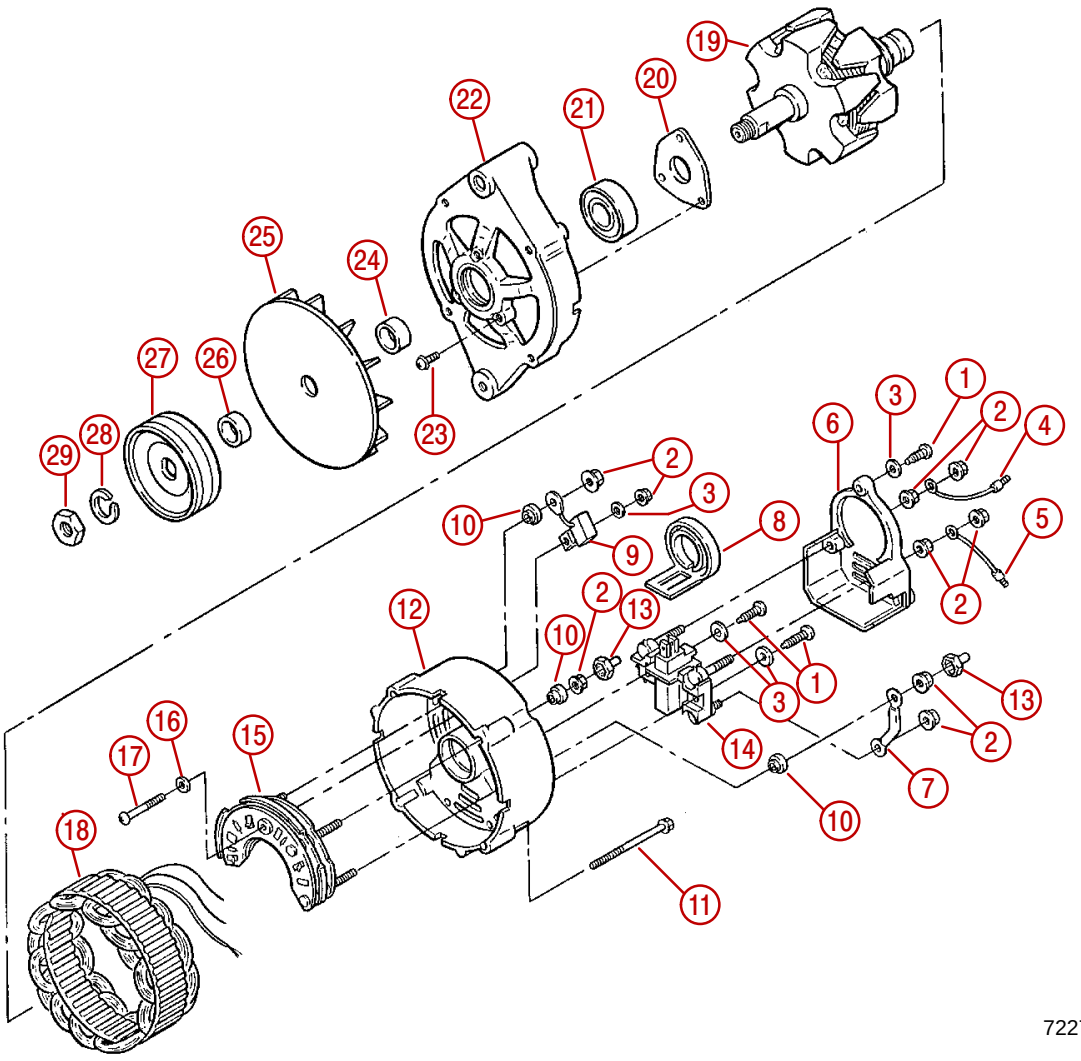
Exploded View



1 - Screws (3)
2 - Nut (9)
3 - Flat Washer (4)
4 - Sensing Wire (RED / PURPLE)
5 - Excitation Wire (PURPLE)
6 - Cover
7 - Tie Strap
8 - Rubber Gasket
9 - Condenser
10 - Insulator (3)
11 - Bolt (4)
12 - End Frame (Rear)
13 - Cap (2)
14 - Brush / Regulator Assembly
15 - Rectifier Assembly
16 - Flat Washer
17 - Screw
18 - Stator
19 - Rotor And Slip Ring
20 - Retaining Plate
21 - Front Bearing
22 - End Frame (Front)
23 - Screw (3)
24 - Fan Spacer
25 - Fan
26 - Pulley Spacer
27 - Pulley
28 - Lockwasher
29 - Nut

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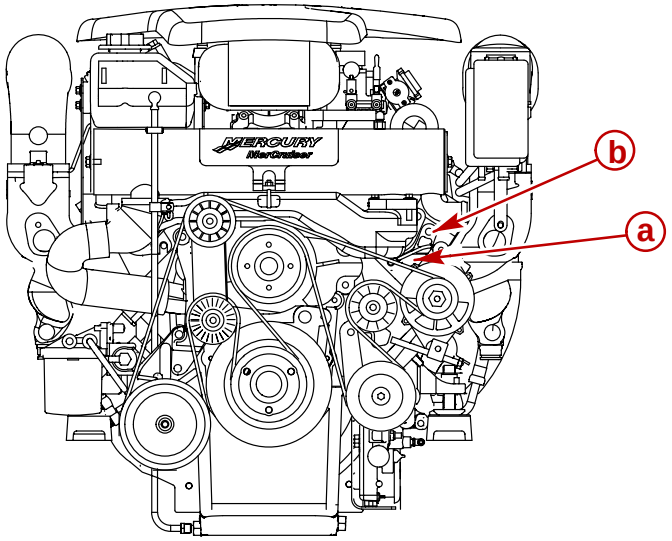
Removal

1. Disconnect negative (–) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Remove drive belt.
4. Remove alternator mounting bolt and washers



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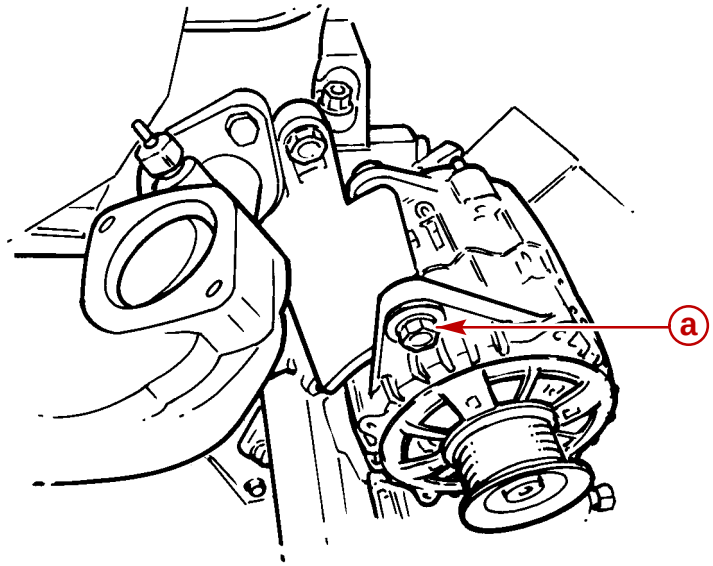
a - Bracket
b - Bolts

5. Remove alternator.

Installation

1. Position alternator in mounting bracket and install mounting bolts. Torque to 35 lb-ft (48 Nm).



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a - Upper Alternator Mounting Bolt

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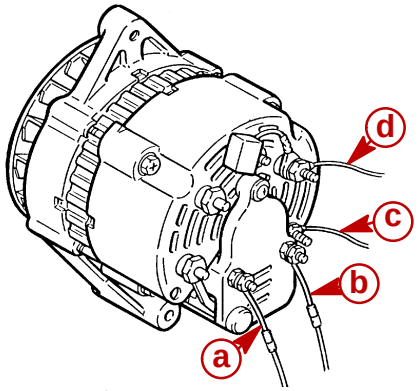
2. Position alternator drive belt on pulleys and adjust tension.
3. Reconnect wiring harness to alternator.

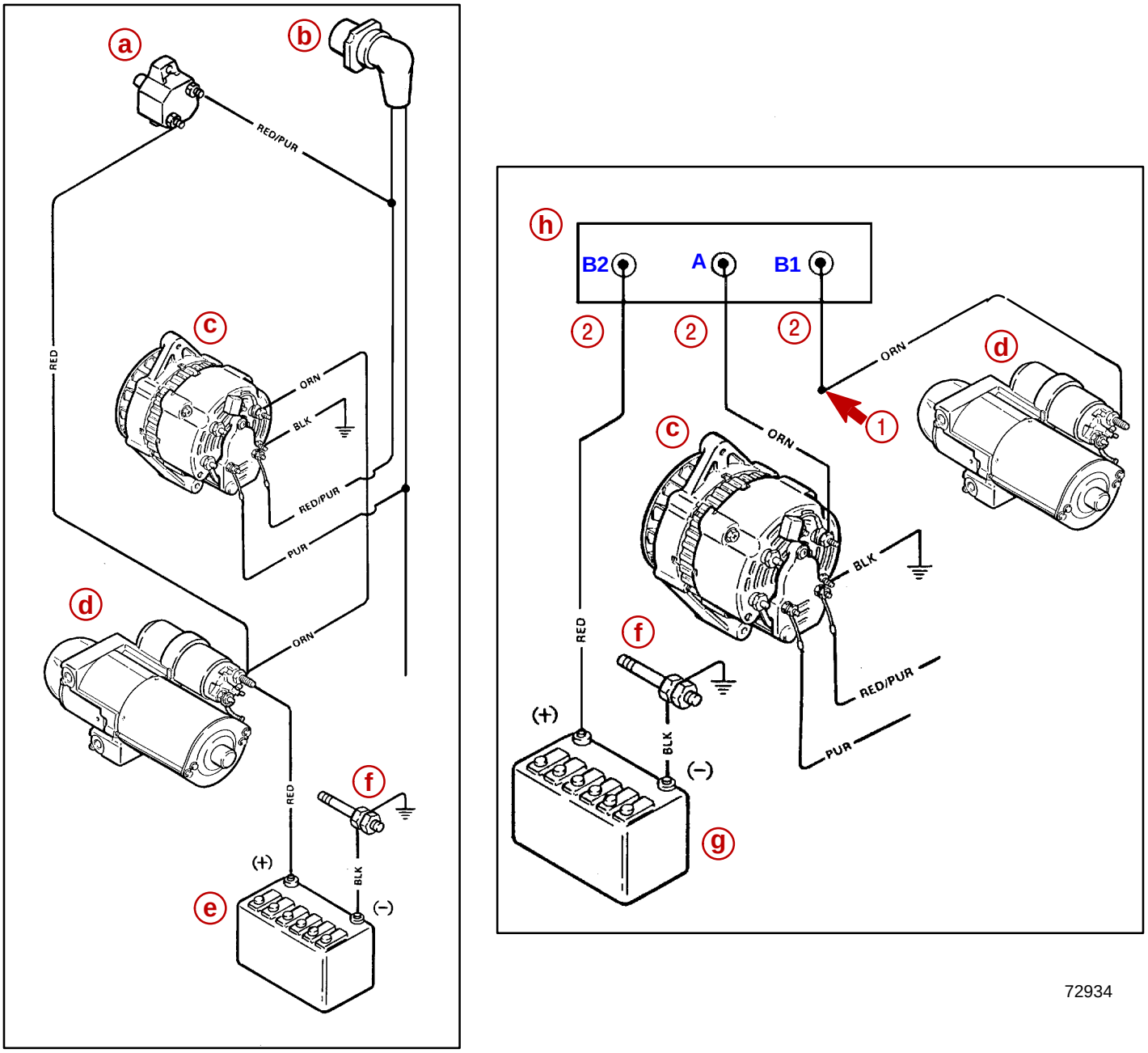


72838

a - Excitation Lead -(PURPLE)
b - Sensing Lead - (RED / PURPLE)
c - Ground Lead - (BLACK)
d - Output Lead - (ORANGE)

4. Connect negative battery cable to battery.

Battery Isolator Diagram



72934

a - Circuit Breaker
b - Harness Connector
c - Alternator
d - Starter
e - Cranking Battery
f - Ground Stud
g - Auxiliary Battery
h - Isolator

1 - Disconnect Orange Wire From Alternator Battery Terminal. Splice Sufficient Gauge Wire To The Orange Wire And Connect As Shown.
2 - 8 Gauge Minimum

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FUEL SYSTEM

Section 5A - Fuel Delivery System For Electronic Fuel Injection

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5 A

Specifications

Description	Specification
Pump Pressure	6 psi (41 kPa)

Torque Specifications

Fastener Location	lb in.	lb ft	Nm
Fuel Lines		18	24
Fuel Fittings	See Note		
Cool Fuel Assembly Mounting Nuts		30	41
Stepped Screw	81		9
Regulator Mounting Screw	53		5.8

Tools

Description	Part Number
Fuel Pressure Gauge	Obtain Locally
Fuel Line At Fuel Rail Remover	Obtain Locally

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
#592 Loctite Pipe Sealant with Teflon	Obtain Locally
Thermal Grease	Obtain Locally
Loctite 242 Threadlocker	Obtain Locally

Precautions

⚠ WARNING

Electrical, ignition and fuel system components on your Mercury MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure that no fuel leaks exist before closing engine hatch

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER TIGHTEN.**
- **Install fuel line. To prevent over tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

IMPORTANT: The installation of additional filters may cause:

- **Fuel Vapor Locking**
- **Difficult Warm-Starting**
- **Piston Detonation Due to Lean Fuel Mixture**
- **Poor Driveability**

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Abbreviations

in. hg	Inches Of Mercury	IGN	Ignition
BARO	Barometric Pressure	INJ	Injection
BAT	Battery Positive Terminal, Battery or System Voltage	kPa	Kilopascal
B+	Battery Positive	KS	Knock Sensor System
CKT	Circuit	KV	Kilovolts
CONN	Connector	MAP	Manifold Absolute Pressure
CYL	Cylinder	MAT	Manifold Air Temperature
DEG	Degrees	mSec	Millisecond
DIAG	Diagnostic	N/C	Normally Closed
DIST	Distributor	N/O	Normally Open
DLC	Data Link Connector	PROM	Programmable Read Only Memory
DTC	Diagnostic Trouble Code	RAM	Random Access Memory
DVOM	Digital Volt Ohm Meter	REF HI	Reference High
ECM	Engine Control Module	REF LO	Reference Low
ECT	Engine Coolant Temperature	ROM	Read Only Memory
EEPROM	Electronic Erasable Programmable Read Only Memory	SLV	Slave
EMI	Electromagnetic Interference	TACH	Tachometer
ENG	Engine	TERM	Terminal
GND	Ground	TP	Throttle Position
GPH	Gallons Per Hour	V	Volts
IAC	Idle Air Control	VAC	Vacuum
IAT	Intake Air Temperature	WOT	Wide Open Throttle
IC	Ignition Control		

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Fuel Delivery System

Recommendations

⚠ WARNING

Boating standards (NMMA, ABYC) and Coast Guard regulations must be adhered to when installing fuel delivery system.

The Fuel Tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank or boat manufacturer.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

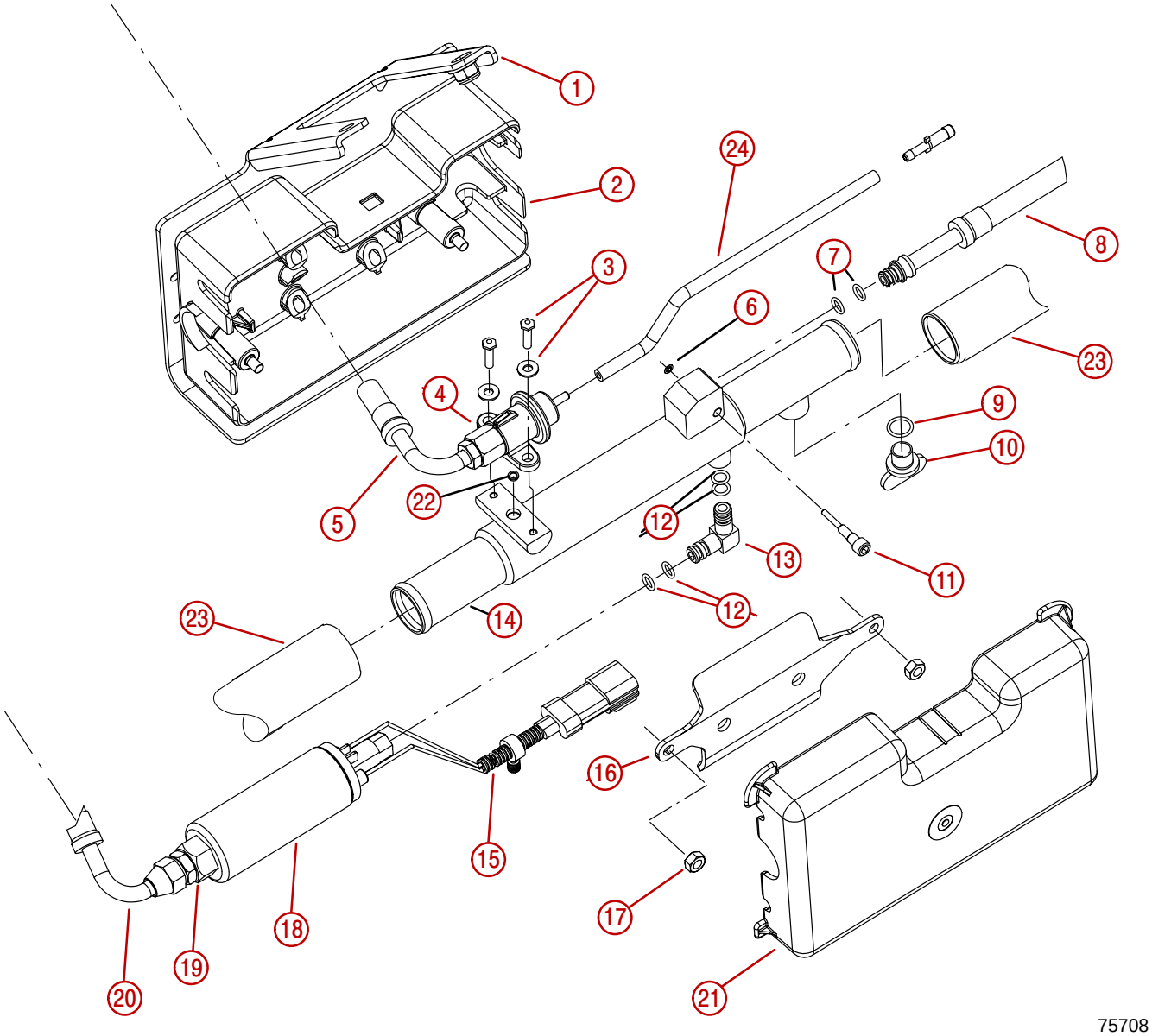
The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered. Refer to boating standards (NMMA, ABYC) and Coast Guard regulations for complete guidelines.

1. Fuel pickup should be at least 1 in. (25 mm) from the bottom of fuel tank to prevent picking up impurities.
2. Fuel lines used must be Coast Guard approved (USCG Type A1).
3. Diameter of fittings and lines must be smaller than 3/8 in. (10 mm) ID.

IMPORTANT: Vacuum reading higher than specified can cause vapor locking with some of today's fuels. It can also cause poor engine performance due to fuel starvation.

4. The maximum measured vacuum at the engine's fuel inlet must not exceed 2 in. Hg (6.9 kPa) at 650, 3000, wide open throttle (wot) and at idle rpm.
5. **On Multi-Engine Gasoline Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must not be smaller than 1/2 in. (13mm) I.D.
6. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
7. Fuel lines should be installed free of stress and firmly secured to prevent vibration and/or chafing.
8. Sharp bends in fuel lines should be avoided.
9. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

Cool Fuel System Exploded View



1 - Bracket
2 - Cover Base
3 - Screw and Washer (2)
4 - Fuel Pressure Regulator
5 - Return Fuel Line
6 - Retaining Ring
7 - O-Rings (2)
8 - Fuel Line To Fuel Rail
9 - Gasket
10 - Drain Plug
11 - Stepped Screw
12 - O-Rings (4)
13 - Elbow
14 - Fuel Cooler
15 - Fuel Pump Wiring Harness
16 - Retainer Bracket
17 - Nut (2)
18 - Electric Fuel Pump
19 - Inlet Fitting
20 - Fuel Line Inlet
21 - Cover
22 - Filter
23 - Seawater Hoses (Hose Clamps Not Shown)
24 - Vacuum Hose

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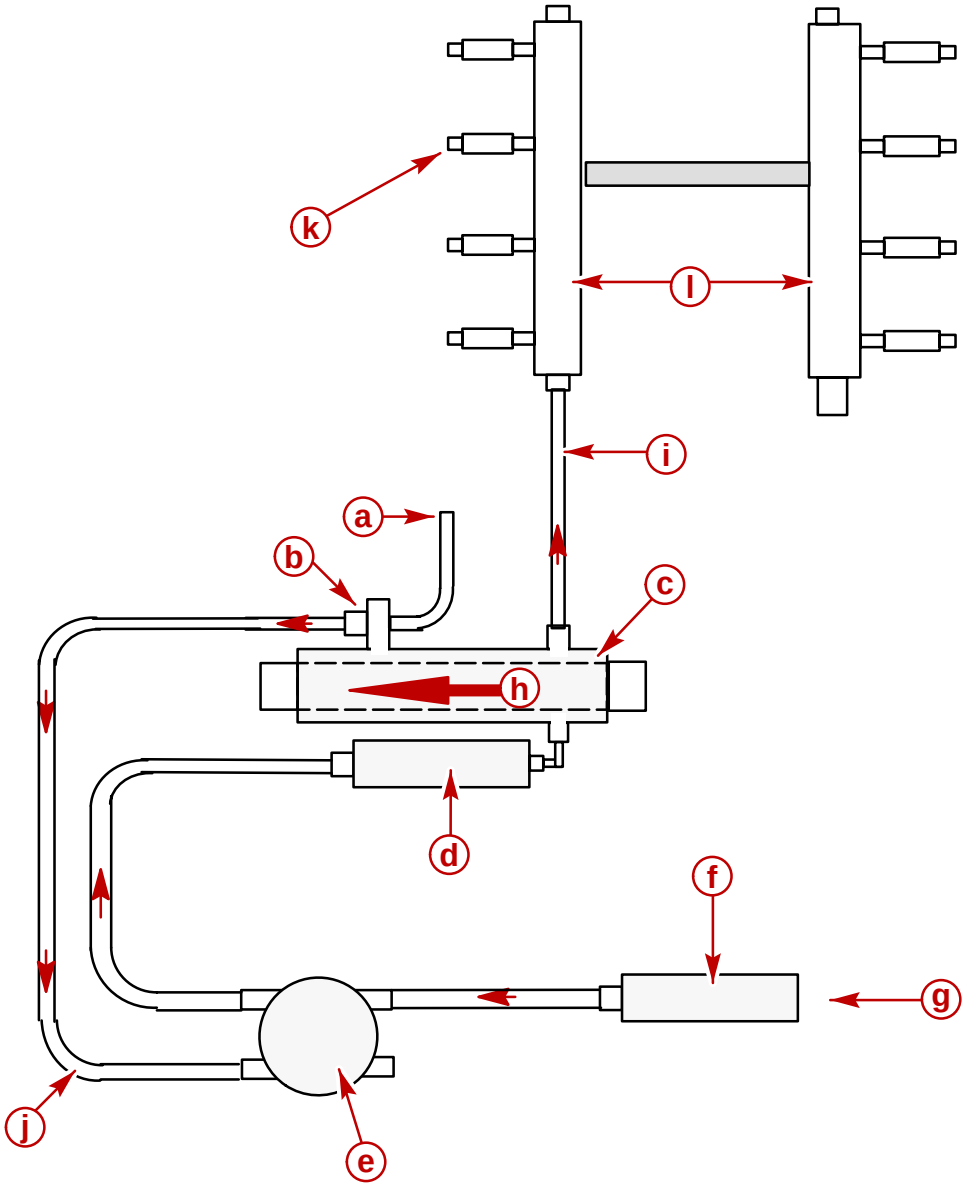
Fuel System Flow Diagrams

Multi-Port Injection



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a - Vacuum Line To Intake Manifold Base
b - Fuel Pressure Regulator
c - Fuel Cooler
d - Electric Fuel Pump
e - Water Separating Fuel Filter
f - Fuel Boost Pump
g - Fuel From Tank
h - Direction Of Water Flow
i - Fuel Line To Fuel Rail
j - Excess Fuel Return To Water Separating Fuel Filter
k - Fuel Injectors (8)
l - Fuel Rail

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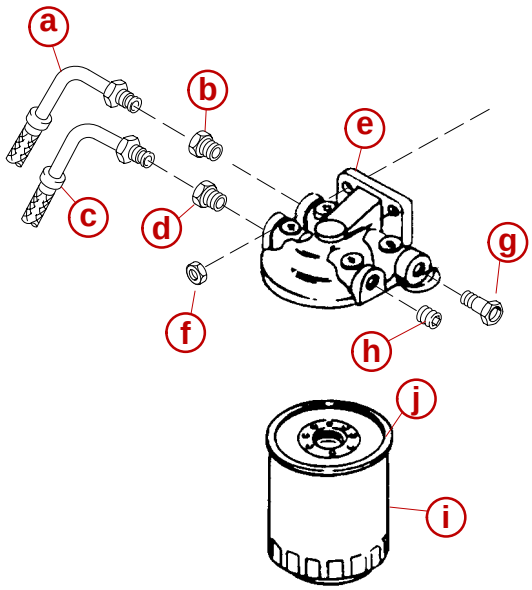
Water Separating Fuel Filter



a - Fuel Return Line from Regulator
b - Brass Fitting
c - Fuel Line to Fuel Pump
d - Brass Fitting
e - Fuel Filter Mounting Bracket
f - Nut
g - Fuel Inlet Fitting
h - Plug
i - Water Separating Fuel Filter
j - Sealing Ring Location

Removal

1. Remove water separating fuel filter and sealing ring from mounting bracket.
2. Discard filter and sealing ring.

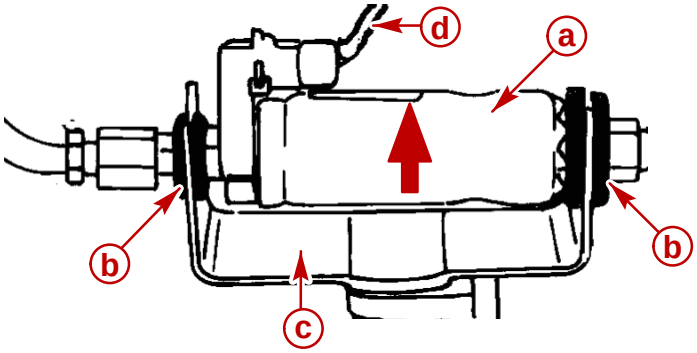
Installation

1. Coat sealing ring on new water separating fuel filter with new engine oil.
2. Thread water separating fuel filter onto bracket and tighten securely by hand. Do not use a filter wrench.
3. Start and operate engine. Check connections for gasoline leaks. If leaks exist, stop engine immediately and recheck filter installation.

Fuel Boost Pump

Removal

1. Disconnect battery cables from battery.
2. Remove the fuel tank inlet line at the fuel boost pump and plug the line.
3. Disconnect the electrical harness to the fuel boost pump.
4. Remove the fuel line from the fuel boost pump at the water separating fuel filter base.
5. Press fuel boost pump toward the engine to remove from the bracket.



75523

a - Fuel Boost Pump
b - Rubber Grommets
c - Bracket
d - Electrical Harness

6. Remove fuel line from fuel boost pump.

Installation

1. Place fuel boost pump in the bracket.
2. Attach the fuel line between the water separating fuel filter and the fuel boost pump.
3. Connect the electrical harness to the fuel boost pump.
4. Attach the fuel tank inlet line.
5. Connect battery cables to battery.
6. Start and operate engine. Check connections for gasoline leaks. If leaks exist, stop engine immediately and recheck pump installation.

Cool Fuel System Repair

Removal

1. Disconnect battery cables from battery.

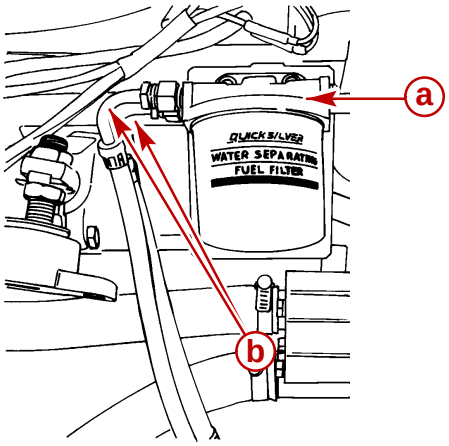
IMPORTANT: Suitably plug open ends of fuel line connections to prevent fuel leaks and entry of water or contaminates into lines while working.

2. Close fuel shutoff valve, if equipped, and remove the fuel tank inlet line from the fuel boost pump. If boat is not equipped with a fuel tank shut off valve, remove the fuel tank inlet line at the fuel boost pump and plug the line.

⚠ CAUTION

If boat is to remain in the water, the seacock, if equipped, must remain closed until engine is to be restarted to prevent water from flowing back into seawater cooling system. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine

3. Close seacock, if equipped. If boat is not equipped with a seacock, remove and plug the seawater inlet hose.
4. Drain seawater system. Refer to SECTION 1B.
5. Disconnect seawater hoses from fuel cooler.
6. Disconnect fuel lines from water separating fuel filter adapter.



75533

a - Water Separating Fuel Filter Adapter
b - Fuel Lines

7. Remove and plug the fuel inlet line to the boost pump.
8. Disconnect the fuel line from the fuel rail using the Fuel Line Remover Tool.
9. Disconnect the fuel pump electrical connector.
10. Disconnect the vacuum hose connected to the pressure regulator in the cool fuel system.
11. Remove the two upper engine mount bracket nuts retaining fuel cooler bracket to the engine.
12. Carefully remove the cool fuel system assembly.

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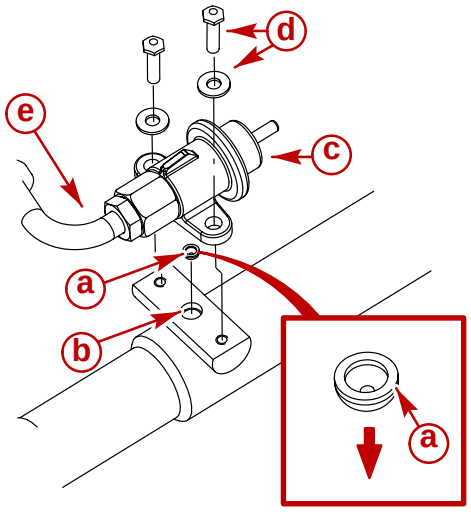
Disassembly

NOTE: *Retain all fasteners and hardware unless instructed otherwise.*

1. Remove the two nuts from the cool fuel retaining bracket studs. Lift the retainer bracket and cooler/pump assembly from the cover base.
2. Disconnect the fuel lines from the assembly.
3. Disconnect the elbow fitting and fuel pump from the cooler assembly.
4. Remove the elbow fitting from the fuel pump (to allow replacement of O-rings during assembly).
5. Remove the two screws retaining the fuel pressure regulator to the fuel cooler.
6. Remove the regulator.
7. Remove and retain the seawater drain plug and seal from the cooler.

Reassembly

1. Install the small filter (conical side DOWN) in the orifice of the new fuel cooler where the fuel pressure regulator mounts.
2. Install the regulator onto the cooler using the two screws with washers. Torque screws to 53 lb-in. (5.8 Nm).
3. Connect the fuel line to the regulator. Tighten securely.



75708

a - Filter
b - Fuel Cooler Orifice
c - Pressure Regulator
d - Screw and Washer
e - Fuel Line

4. Install the fuel rail fuel line as follows

   a. Install two (of six) O-rings onto the cooler-to-fuel rail fuel line where it attaches to the cooler, if not already present.

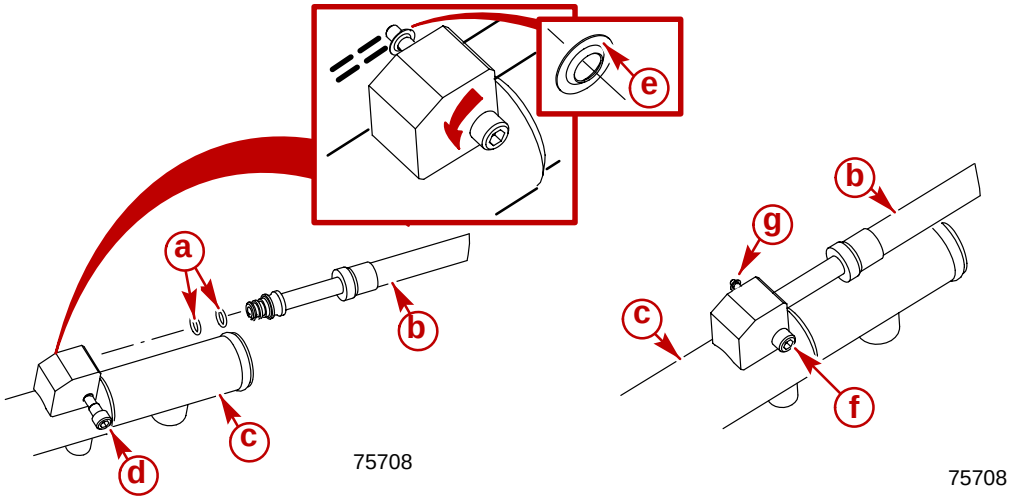
   b. Completely loosen, but do NOT remove, the stepped screw that retains the fuel line.

   c. Lubricate the two fuel line O-rings with a small amount of liquid dish soap (obtain locally).

   d. Insert the fuel line into the cooler orifice. Hand tighten the stepped screw.

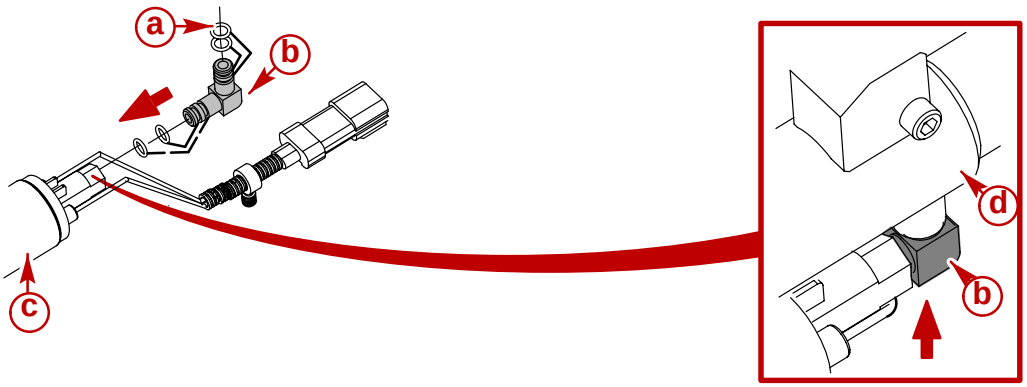
   e. Torque the stepped screw to 81 lb-in. (9 Nm).

IMPORTANT: To prevent loss of the stepped screw used to secure the cooler-to-fuel rail fuel line, a retainer ring is provided. Do not remove the retainer or stepped screw.



a - Fuel Line O-Rings
b - Fuel Line, Cooler-to-Fuel Rail
c - Fuel Cooler
d - Stepped Screw - Loosened To Accept Fuel Line
e - Retainer Ring
f - Stepped Screw - Torqued
g - Retainer Ring

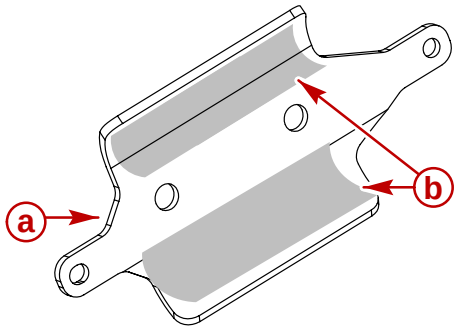
5. Install the fuel pump to the cooler as follows:
   a. Install the remaining four (of six) O-rings on the fuel pump / cooler elbow fitting as shown.
   b. Lubricate O-rings for the elbow fitting with a small amount of liquid dish soap (obtain locally).
   c. Install the elbow in the fuel pump.
   d. Install the fuel pump with elbow fitting in the cooler assembly.



75708

a - O-Rings (4)
b - Elbow Fitting
c - Fuel Pump
d - Fuel Cooler

6. Position the completed fuel cooler assembly in the cover base.
7. Apply a thin, even coating of thermal grease on all of the retainer bracket inside surfaces where it contacts the cooler and the fuel pump when installed.

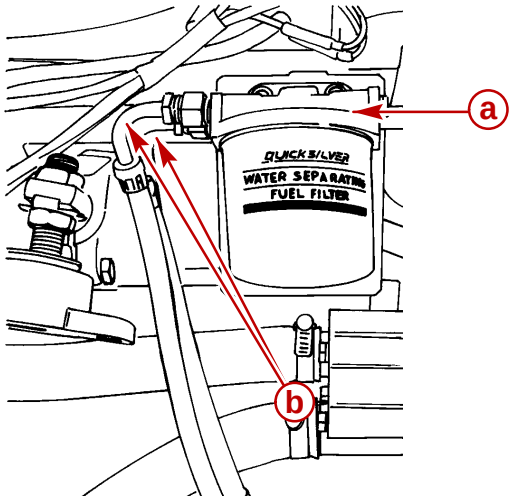


a - Retainer Bracket
b - Thermal Grease

8. Install the retainer bracket over the cooler and fuel pump. Apply Loctite 242 to the threads of the mounting studs. Torque the two nuts to 50 lb-in. (5.6 Nm).
9. Install and securely tighten the seawater drain plug.

Installation

1. If removed, reinstall the fuel filter assembly and secure using the two self locking nuts. Tighten securely.
2. Connect the fuel lines to the fuel filter adapter. Tighten securely.



a - Filter Adapter
b - Fuel Lines

3. Route the fuel lines as needed and place the Cool Fuel assembly on the engine mount studs. Install the two engine mounting nuts. Torque to 30 lb-ft (41 Nm).
4. Install the cooler-to-fuel rail line as follows:
   a. Route the fuel line to the back side of engine.
   b. Connect the fuel line to the fuel rail fitting.
5. Connect vacuum line to fuel pressure regulator at cool fuel box.
6. Attach engine harness electrical connector to fuel pump harness connector.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

7. Connect seawater hoses to cool fuel system. Tighten hose clamps securely.
8. Unplug and connect seawater inlet hose. Open seacock, if equipped.
9. Unplug and connect fuel tank supply inlet hose. Tighten hose clamp securely. Open fuel shutoff valve, if equipped.

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⚠ CAUTION

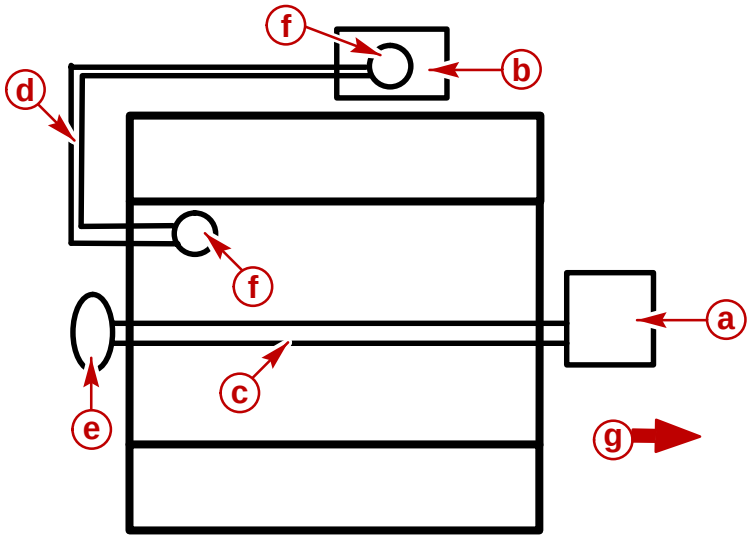
When installing battery, be sure to connect POSITIVE (+) battery cable to POSITIVE (+) battery terminal FIRST, and NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal LAST. If battery cables are reversed, or connection order is reversed, electrical system damage will result.

10. Clean battery cable clamps and terminals and reconnect cables (see **CAUTION** listed above). Secure each cable clamp when connecting. Coat terminals with a battery terminal anti-corrosion spray to help retard corrosion.
11. Start the engine and check for fuel and water leaks. Stop the engine immediately if any leaks exist. Make necessary corrections.

⚠ WARNING

Make sure no leaks exist before closing engine hatch.

Vacuum And Vent Hose Routing



77644

a - Throttle Body
b - Cool Fuel Assembly
c - Vent Hose - Throttle Body To Idle Air Control
d - Vacuum Hose - Fuel Regulator On The Intake To Fuel Regulator In The Cool Fuel Assembly
e - Idle Air Control
f - Fuel Regulator
g - Front of Engine

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FUEL SYSTEM

Section 5B - Fuel Injection Disassembly And Reassembly

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5 B

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

⚠ WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

⚠ WARNING

Make sure no fuel leaks exist, before closing engine hatch.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

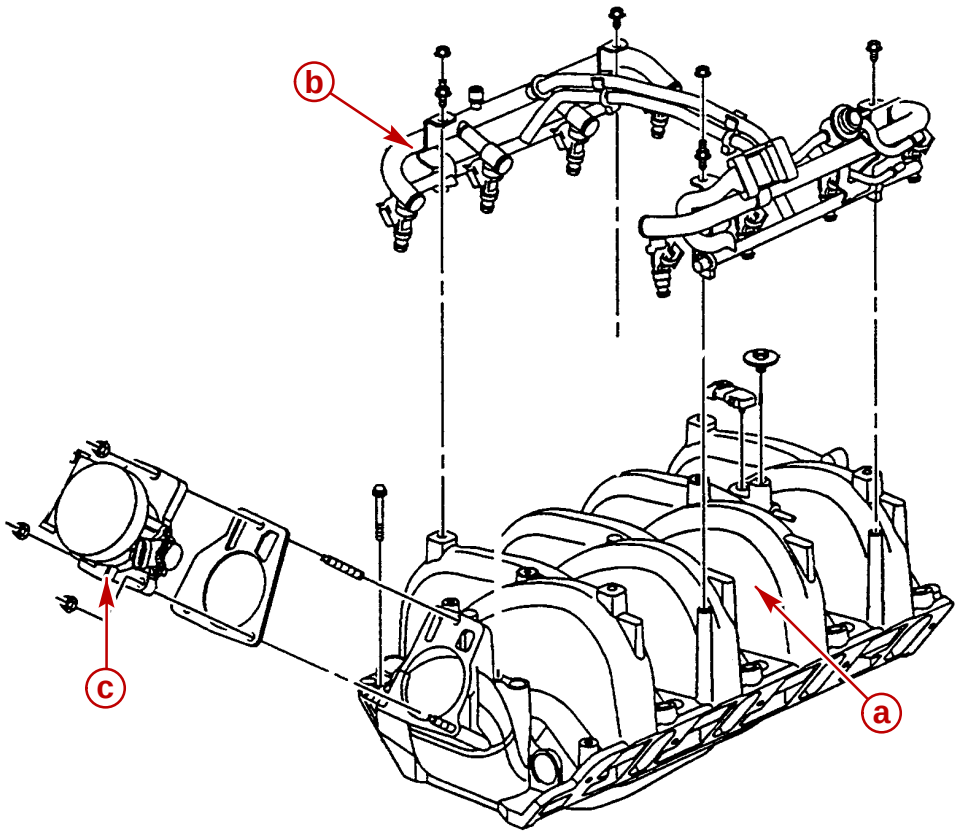
The following information MUST BE adhered to when working on the fuel system:

- **Always keep a dry chemical fire extinguisher at the work area.**
- **Always install new O-rings when assembling fuel pipe fittings.**
- **DO NOT replace fuel pipe with fuel hose.**
- **DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.**
- **Observe all Notes, Warnings and Cautions.**

Torque Specifications

Description	lb-in.	lb-ft	Nm
TP Sensor	20		2
IAC Valve	20		2
MAP Sensor	53		6
Knock Sensor to Block		14	19
Intake Manifold to Plenum	150		17
Fuel Rail	105		12
Fuel Line Connections		18	24
Fuel Inlet and Return Lines		23	31
Throttle Body-To-Intake Manifold	89		10
ECT Sensor	Hand Tight + 2 1/2 turns maximum		
Flame Arrestor Cover Bracket	Tighten Securely		
Flame Arrestor Clamp			

Intake Manifold, Fuel Rail And Throttle Body Exploded View



76681

a - Intake Manifold
b - Fuel Rail
c - Throttle Body

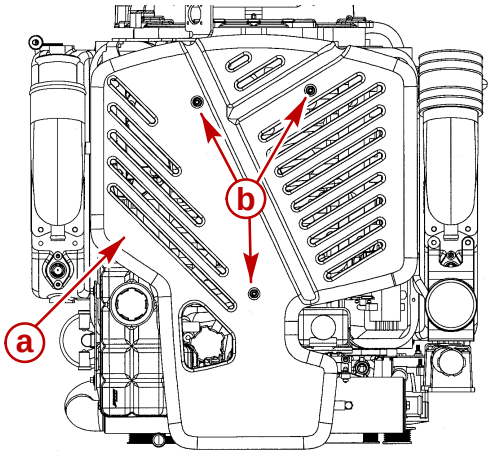
Fuel Pressure Relief Procedure

1. Disconnect electrical connectors at both fuel pumps.
2. Crank engine for ten seconds (if engine starts allow it operate until it stops) to relieve any fuel pressure in the system.

Flame Arrestor

Removal

1. Remove the engine cover.



77631

a - Engine Cover
b - Fasteners

2. Loosen the clamp and remove the flame arrestor.

Cleaning and Inspection

1. Clean flame arrestor in solvent.
2. Wear eye protection. Dry flame arrestor with compressed air.

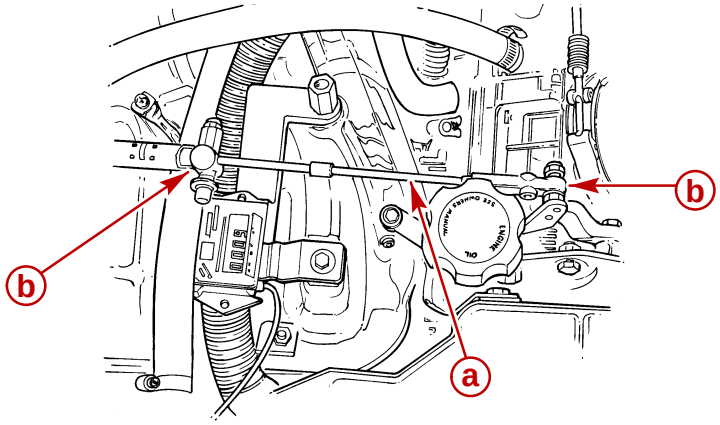
Installation

1. Reinstall flame arrestor and fastening hose clamp. Tighten fastener securely.
2. Install engine cover. Secure with fasteners.

Throttle Body

Removal

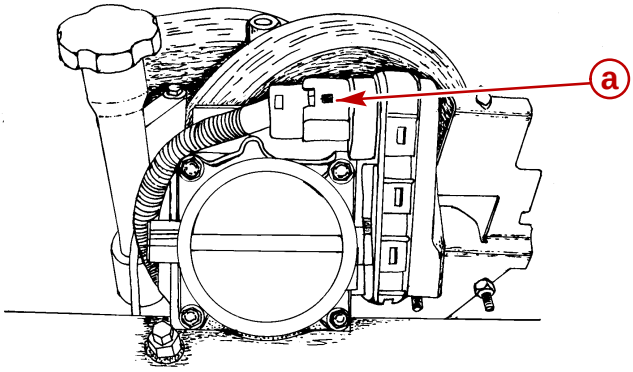
1. Remove the engine cover.
2. Remove the flame arrestor.
3. Disconnect the throttle linkage from the throttle body.



77597

a - Throttle Cable
b - Throttle Cable Connections

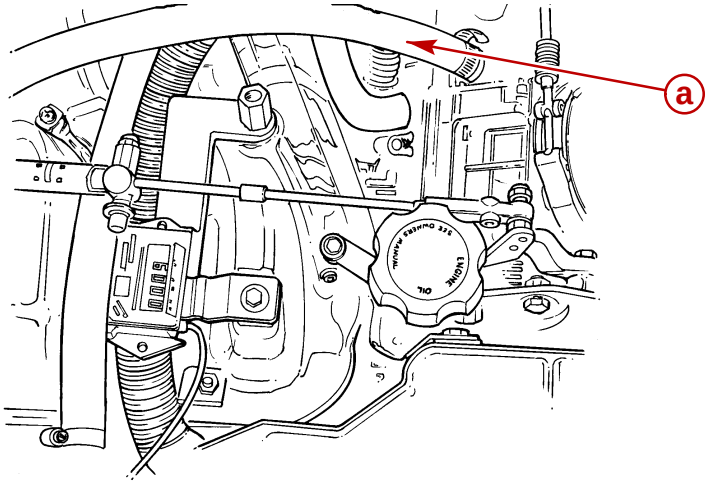
4. Disconnect the electrical harness from the TP sensor.



77641

a - Throttle Position Sensor Connector

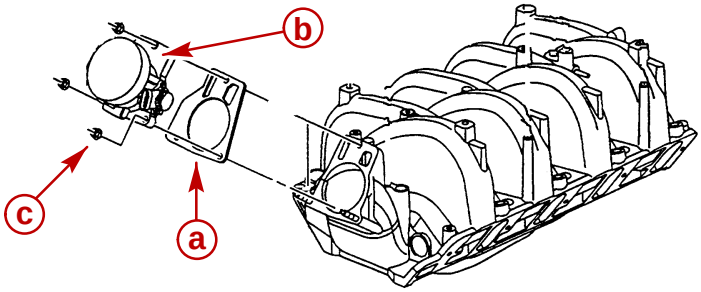
5. Disconnect hose to IAC valve.



77597

a - Hose To IAC Valve

6. Remove the nuts(3) retaining the throttle body and remove the throttle body from the intake.



76681

a - Gasket
b - Throttle Body
c - Nuts

IMPORTANT: Insert a clean shop towel into the opening of the intake to prevent foreign material from entering the engine.

Cleaning and Inspection

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

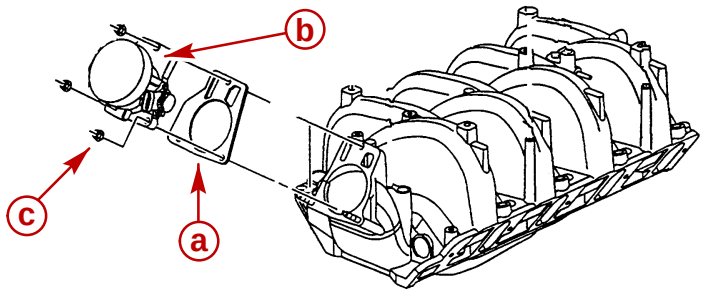
IMPORTANT: DO NOT allow the TP sensor to come into contact with solvent or cleaner.

IMPORTANT: Use care when removing gasket material from intake manifold and throttle body.

1. Carefully remove all gasket material from intake manifold and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage and return springs for damage, wear and foreign material.

Installation

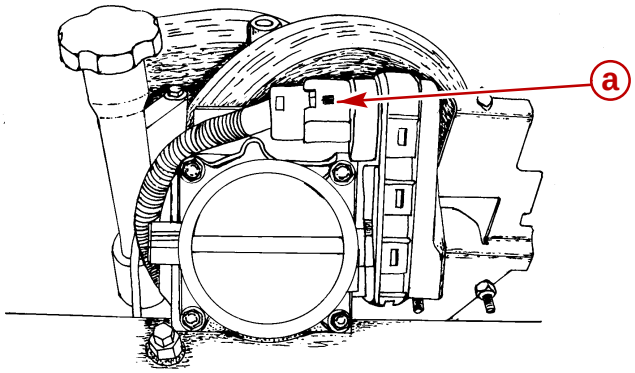
1. Install the throttle body gasket between the throttle body and the intake manifold.
2. Install the throttle body on the intake manifold. Fasten with nuts and torque to 89 lb-in. (10 Nm).



76681

a - Gasket
b - Throttle Body
c - Nuts

3. Connect the harness connector to the TP sensor.



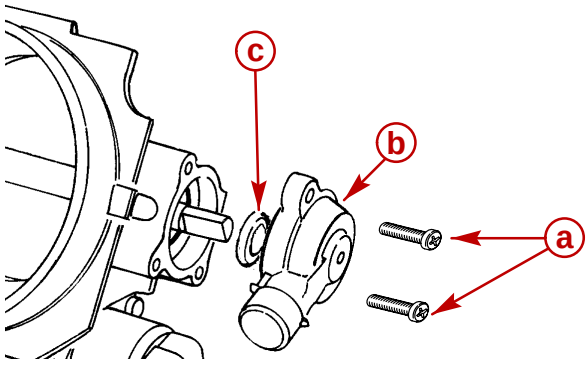
77641

a - Throttle Position Sensor Connector

4. Connect the throttle cable to the throttle lever. Refer to SECTION 2 for throttle cable adjustment.
5. Install the flame arrestor and tighten the clamp.
6. Install the engine cover.

Throttle Position Sensor

1. Remove the engine cover.
2. Remove the flame arrestor from the throttle body.
3. Disconnect the harness connector from the TP sensor.
4. Remove the throttle body from the intake manifold.
5. Disconnect the harness connector from the TP sensor.
6. Remove the screws from the TP sensor.
7. Remove the TP sensor from the throttle body.



75832

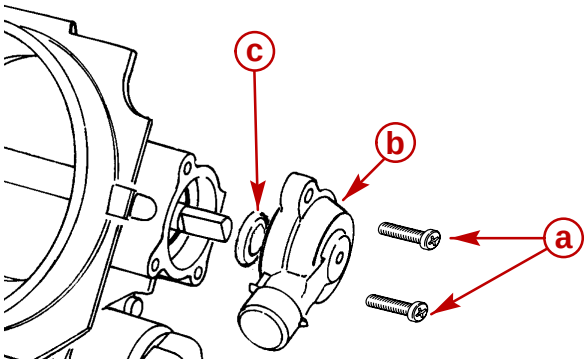
a - Screw (2)
b - Throttle Position (TP) Sensor
c - Dust Seal

Cleaning and Inspection

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the sensor for signs of wear or damage.

Installation

1. Apply Loctite 242 to screw threads. Install the TP sensor and dust seal on the throttle body using the screws. Torque screws to 20 lb-in. (2 Nm).



75832

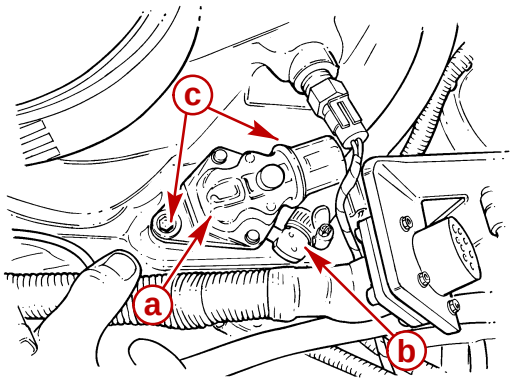
a - Screw (2)
b - Throttle Position (TP) Sensor
c - Dust Seal

2. Place a new gasket on the intake manifold.
3. Install throttle body on the intake manifold. Torque screws to 89 lb-in. (10 Nm).
4. Connect the harness connector to the TP sensor.
5. Place the flame arrestor over the throttle body and tighten clamp securely.
6. Install the engine cover. Tighten fasteners securely.
7. When negative (–) battery cable has been reconnected, start engine and check for TP sensor output voltage. It should be approximately 0.7 Volts at idle and 4.5 Volts at wide open throttle.

Idle Air Control (IAC) Valve

Removal

1. Remove the engine cover.
2. Remove hose from throttle body at the IAC.
3. Disconnect harness electrical lead.
4. Remove the 2 female hex bolts fastening the IAC valve at the rear of the engine.



77487

a - IAC Valve
b - Hose Connection
c - Female Hex Bolts (1 Hidden)

Cleaning and Inspection

IMPORTANT: Refer to carburetor cleaner manufacturers instructions for safety precautions.

1. Remove and discard sealing gasket from IAC valve. Clean sealing surfaces and air passage with a carburetor cleaner to remove carbon deposits.
2. Inspect the entire assembly for any obvious physical damage.

Installation

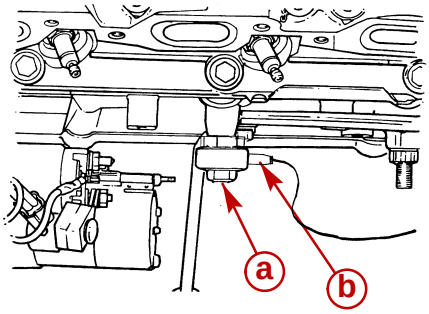
IMPORTANT: If installing a new IAC valve, be sure to replace it with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

1. Install new gasket on IAC valve.
2. Install IAC valve in throttle body using screws. Torque to 20 lb-in. (2 Nm).
3. Connect hose from throttle body.
4. Connect harness electrical lead to the IAC.
5. Start engine and check for proper idle operation.

Knock Sensor

Removal

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



75678

a - Knock Sensor
b - Electrical Connector

2. Remove knock sensor from engine block.

Cleaning and Inspection

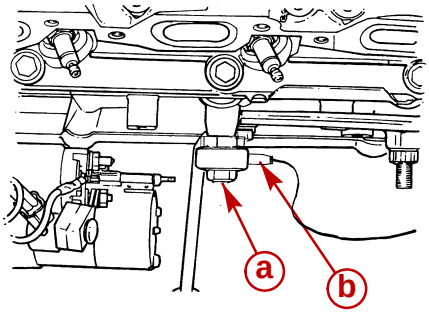
1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

Installation

IMPORTANT: If installing a new knock sensor, replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

1. Install knock sensor in engine block. Torque to 14 lb-ft (19 Nm).



75678

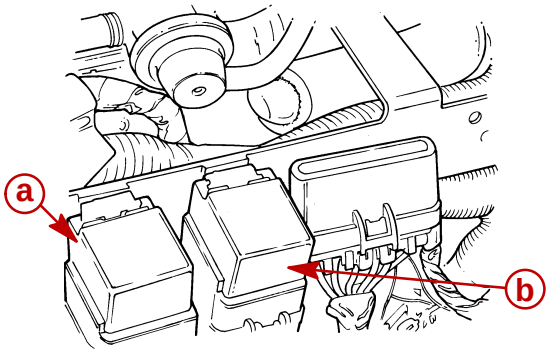
a - Knock Sensor
b - Electrical Connector

2. Connect electrical connector to knock sensor.

Main System And Fuel Pump Relays

Removal

1. Remove relays from electrical bracket.



77602

a - Fuel Pump Relay
b - Main System Relay

2. Remove top cap from relay.

Cleaning and Inspection

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

Installation

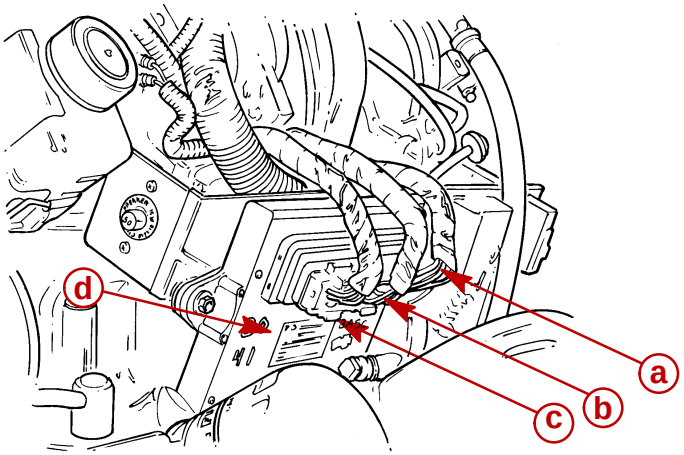
1. Connect top cap to relays.
2. Attach relays to electrical bracket.

Electronic Control Module (ECM)

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. DO NOT touch connector pins when removing or installing the module.

Removal

1. Disconnect A, B and C electrical connectors at engine control module (ECM). DO NOT touch connector pins when removing.



77498

a - Connector A
b - Connector B
c - Connector C
d - ECM

2. Remove ECM from electrical bracket.

Cleaning and Inspection

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage.
3. Visually inspect electrical pins on ECM for straightness and corrosion.
4. Visually inspect connectors on the wiring harness for corrosion and terminals that may have loose connections.

NOTE: *The ECM is a sealed electrical component. If ECM is shown to be defective the unit must be replaced with an ECM of the same part number.*

Installation

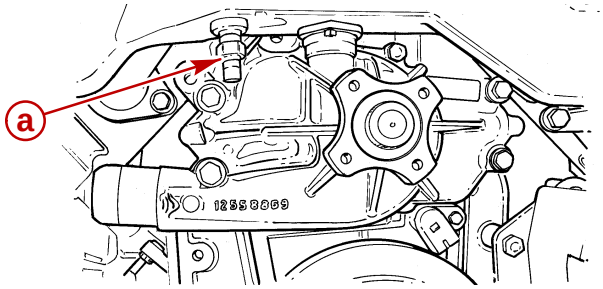
1. Mount new ECM to electrical bracket using screws and washers.
2. Connect electrical connectors to the ECM. DO NOT touch connector pins when installing.

Engine Coolant Temperature (ECT) Sensor

Removal

IMPORTANT: Handle the ECT carefully as any damage to it will affect operation of the system.

1. Disconnect electrical connector at engine coolant temperature (ECT) sensor.



77097

Water Pump Pulley Removed For Visual Clarity

a - Engine Coolant Temperature Sensor (ECT)

2. Remove ECT sensor from crossover.

Cleaning and Inspection

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT sensor.

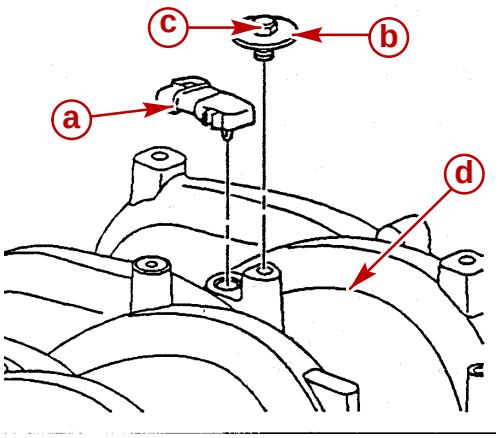
Installation

1. Install ECT sensor. Tighten hand tight plus 2-1/2 turns maximum.
2. Connect electrical connector to ECT sensor.

Manifold Absolute Pressure (MAP) Sensor

Removal

1. Disconnect electrical connector from manifold absolute pressure (MAP) sensor.



77647

a - Manifold Absolute Pressure (MAP) Sensor
b - Washer
c - Bolt
d - Intake Manifold

2. Remove MAP sensor from intake manifold.

Cleaning and Inspection

1. Clean the surfaces of the MAP sensor with a dry cloth.
2. Inspect the MAP sensor for signs of wear or damage.
3. Inspect seal on MAP sensor. Replace if deteriorated or hardened.

Installation

1. Install seal on MAP sensor.
2. Install MAP sensor on intake manifold using washer and bolt. Torque screw to 53 lb-in. (5-7 Nm).
3. Connect electrical connector to MAP sensor.

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COOLING SYSTEM

Section 6A - Closed Cooling

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6 A

Torque Specifications

Description	lb-in.	lb-ft	Nm
Heat Exchanger End Cap	54		6
Thermostat Retainer		12	16
Crossover Bolts		37	50
Hose Clamps	Securely		
Drain Plugs			

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Perfect Seal	92-34227--1
Quicksilver Liquid Neoprene	92-25711--3
Loctite Pipe Sealant With Teflon	Obtain Locally

Specifications

Closed Cooling System Capacity

NOTICE
Unit Of Measurement: U.S. Quarts (Liters) **All capacities are approximate fluid measures.**

Model	All Engines
Closed Cooling System	19 (18)

Thermostat

Engine	Specification
496 cid (8.1 l)	160°F (71°C)

Pressure Cap Rating

Engine	Specifications
496 cid (8.1 l)	15 psi (103 kPa)

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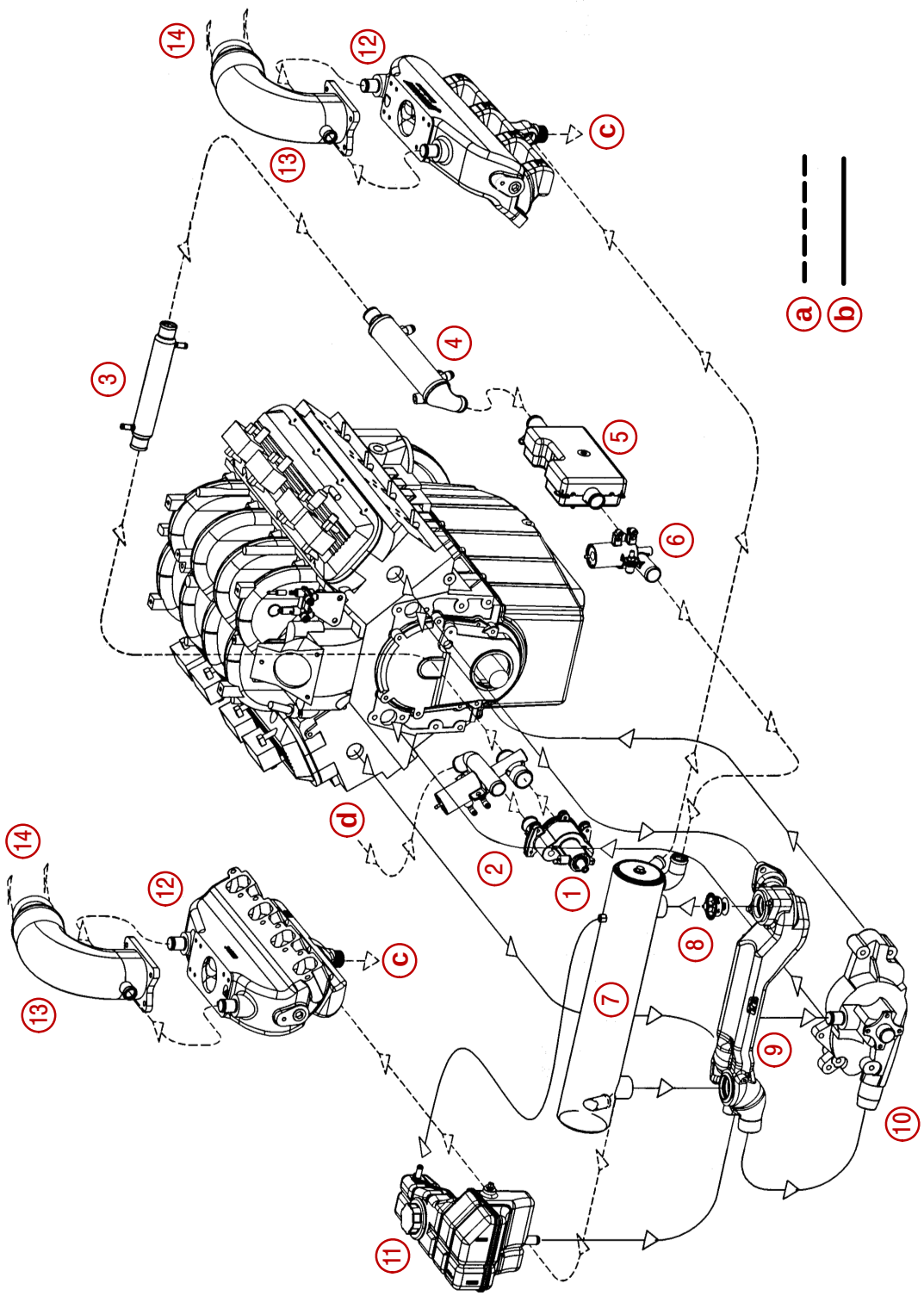
Coolant And Water Flow Diagrams

NOTE: *Certain components in the following diagram may look different than on your particular power package, but the water and coolant flow paths remain similar on all engines.*



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3 - Power Steering Cooler
4 - Oil Cooler
5 - Fuel Cooler
6 - Air Actuator
7 - Heat Exchanger
8 - Thermostat
9 - Crossover
10- Water Circulating Pump
11- Coolant Reservoir
12- Exhaust Manifold
13- Elbow
14- Water And Exhaust Outlet

a - Seawater
b - Coolant
c - To Air Actuator
d - Seawater Inlet

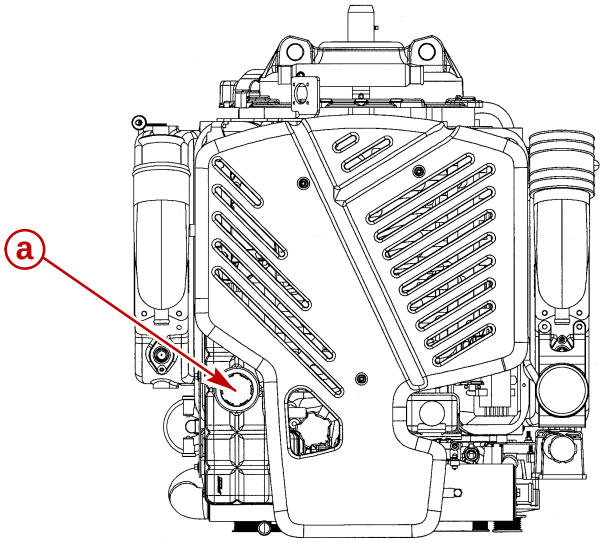
Pressure Cap Maintenance

Pressure cap is designed to maintain pressure in fresh water section of closed cooling system once the engine has attained normal operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, cap should be cleaned and inspected periodically.

⚠ WARNING

Allow engine to cool before removing pressure cap, as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then remove cap.

1. Remove pressure cap from coolant reservoir.
2. Wash cap with clean water to remove any deposits or debris.
3. Inspect cap for cuts, cracks or other signs of deterioration. Replace cap if necessary.



77631

a - Reservoir Pressure Cap

4. Clean sealing surfaces on coolant reservoir. Inspect surfaces for any damage or deposits that may prevent cap from sealing properly.
5. Reinstall pressure cap, tighten securely.

Seawater Pickup Pump Maintenance

Whenever insufficient water flow is suspected, seawater pickup pump should be disassembled and inspected.

Testing Closed Cooling System

Testing Coolant for Alkalinity

⚠ WARNING

Allow engine to cool before removing pressure cap as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then remove cap.

Coolant in fresh water section should be changed per Maintenance Schedule recommendations and should be checked for alkalinity at least once between change intervals.

1. Obtain pink litmus paper from a local supplier.
2. Remove pressure cap from coolant reservoir and insert one end of litmus paper into coolant.
3. **If pink litmus paper turns blue,** coolant is alkaline and need not be replaced.
4. **If pink litmus paper remains pink,** coolant is not alkaline and MUST BE REPLACED, refer to Changing Coolant.

Pressure Testing System

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then remove cap.

If coolant section of closed cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leaking can be found, perform the following test:

1. Remove pressure cap from reservoir.
2. Clean and inspect pressure cap to ensure that cap is maintaining proper pressure in system.
3. Inspect sealing surfaces for debris or damage that would hinder proper sealing.
4. Adjust coolant level to full mark on coolant reservoir.
5. Attach an automotive-type cooling system pressure tester and pressurize closed cooling section to amount specified in following chart, based on pressure cap rating for your engine.

Pressure Cap Rating	Amount of Pressure Applied to Closed Cooling System
15 psi (103 kPa)	19 psi (131 kPa)

6. Observe gauge reading for approximately two minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leak is found.

7. While maintaining specified pressure on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal) for leaks. Also, listen closely for bubbling or hissing; either indicates a leak.
8. If no leaks could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following:

- Loose cylinder head bolts or damaged gasket
- Loose intake manifold bolts or damaged gasket
- Loose exhaust elbow or distribution block retaining nuts or damaged gasket
- Cracked or porous cylinder head or block
- Cracked or porous exhaust manifold.

9. Proceed as follows until location of internal leak is found.
    a. Start engine. Re-pressurize system to previously specified amount and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber.
    b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug that is perfectly clean or milky appearing is an indication of a leak.
    c. Drain oil from engine and examine for presence of coolant. Oil will be milky if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, re-pressurize closed cooling section to previously specified amount and examine internal surfaces of engine to locate leak.
    d. If no leaks can be found in the above steps, entire engine must be disassembled and inspected for leaks.

Heat Exchanger

Testing And Inspection

INTERNAL LEAKS

An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

1. Remove a seawater hose from the heat exchanger. Do not drain the heat exchanger.
2. Pressurize the closed cooling system to 19 psi (131 kPa) with a radiator tester.
3. If seawater begins to flow from the hose fitting, there is a leak.

WATER BLOCKAGE

IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Coolant flows AROUND the tubes.

1. Remove end caps and inspect for any blockage in the seawater circuit.
2. Remove closed cooling circuit hoses and inspect the tubes just inside the hose fitting. The complete heat exchanger cannot be inspected; the heat exchanger should be replaced if is suspected of being blocked.

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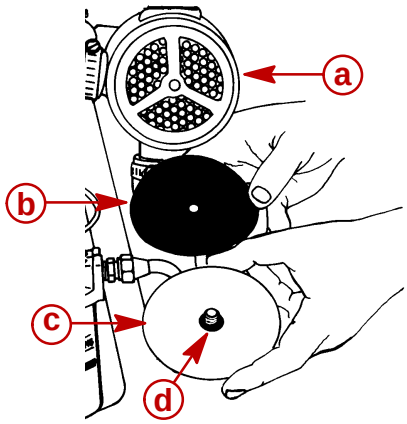
Removal

1. Drain closed cooling system.
2. Disconnect hose from reservoir at the heat exchanger.
3. Remove hoses connected to the heat exchanger.
4. Remove heat exchanger bracket.
5. Loosen thermostat retainer screws.
6. Carefully lift heat exchanger from crossover.

Disassembly

1. Remove bolts which secure end plates to each end of the heat exchanger.
2. Remove end plates, seal washers and gaskets. Discard seal washers and gaskets.



71515

a - Heat Exchanger
b - Sealing Washer
c - End Cap
d - Gasket

Cleaning

Cooling efficiency of an engine with closed cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt or lime) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is recommended that the sea-water section of the heat exchanger be cleaned at least once every two years or whenever decreased cooling efficiency is suspected.

1. Clean gasket material from end plates and heat exchanger.
2. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.

Assembly

1. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets, then reinstall end plates using new gaskets and seal washers. (Be sure to install seal washers between end plates and gaskets.) Torque bolts to 54 lb-in. (6 Nm).

⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without water being supplied to seawater pickup pump.

2. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Heat Exchanger Repair

IMPORTANT: Brazing shut a leaking tube is only a temporary solution. Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. To repair leaking tube, braze shut the ends of the leaking tube. Usually another tube will start leaking after a short period of time causing a reduction in cooling capacity. Do NOT close more than three tubes.
2. Broken nipples and drains can be reattached to the heat exchanger by brazing.

Installation

1. Ensure that thermostat retainer screws are loose.
2. Align heat exchanger onto crossover. Be careful not to damage seal between heat exchanger and crossover.
3. Firmly press heat exchanger into crossover fittings.
4. Tighten thermostat retainer fittings.
5. Install heat exchanger bracket around crossover and heat exchanger. Tighten securely.
6. Install hoses to the heat exchanger.
7. Install hose from coolant reservoir. Tighten hose clamps securely.
8. Fill closed cooling system.

Thermostat

Removal

NOTE: *If coolant flow is restricted or fails to occur, a wire should be repeatedly inserted into drain holes to ensure that there are no obstructions in passages.*

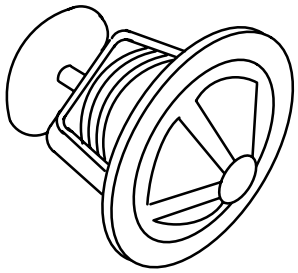
1. Drain seawater portion of cooling system.
2. Drain closed cooling system.
3. Loosen thermostat retainer screws.
4. Remove heat exchanger.
5. Remove 2 screws, washers and thermostat retainer.
6. Remove thermostat.
7. Remove rubber O-ring from thermostat.

Cleaning And Inspection

1. Clean thermostat with soapy water.
2. Inspect O-ring for cuts, scrapes and wear. Replace if necessary.
3. Inspect thermostat retainer for cuts, grooves and wear that would hinder sealing. Replace if necessary.

Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.



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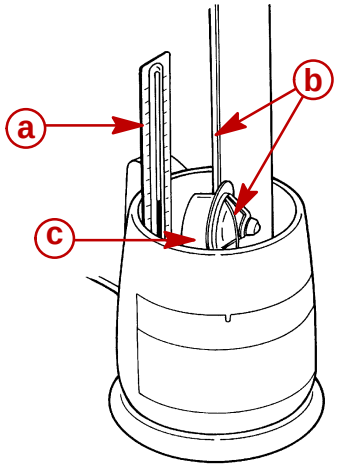
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leaks by holding it up to a lighted background. Light leaking around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A few leaks at one or two points around the valve perimeter is acceptable.)
4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:

   a. Fill tester to within 1 in. (25 mm) of top with tap water. Do not use distilled water.

b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



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a - Thermometer
b - Nylon String
c - Thermostat (Typical)

c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

IMPORTANT: Water must be agitated thoroughly to obtain accurate results in steps d. and e.

d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread).

e. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.

5. Replace a thermostat that fails to meet all of the preceding tests.

Installation

1. Install a new O-ring and thermostat into crossover. Ensure thermostat seats in groove of crossover.
2. Install thermostat retainer with 2 bolts and washers. Do not tighten.
3. Install heat exchanger.
4. Torque thermostat retainer fittings to 12 ft-lb. (16 Nm).
5. Refill closed cooling system.

⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without cooling water being supplied to seawater pickup pump.

6. Start engine and check for leaks.

Crossover

Removal

1. Drain closed cooling system.
2. Loosen retainer bolts.
3. Loosen female hex fastener on heat exchanger strap.
4. Remove heat exchanger retaining strap.
5. Remove heat exchanger.
6. Remove thermostat retainer.
7. Remove thermostat.
8. Remove hose from reservoir.
9. Remove harness connection to water temperature sender and sensor.
10. Loosen hose clamp on water pump bypass hose.
11. Loosen hose clamp on water inlet hose.
12. Remove 2 bolts and gasket from crossover connections at the cylinder heads. Retain bolts and gaskets.
13. Lift crossover from engine.

Inspection

1. Inspect sealing surfaces for cracks, cuts and wear.
2. Inspect pipe plugs for cracks.
3. Inspect hose connections for wear and debris.
4. Inspect heat exchanger pads for wear.
5. Inspect gaskets for wear.
6. Ensure that sealing surfaces are clean.

Installation

1. Align water pump bypass and inlet hoses with crossover.
2. Install crossover onto engine.
3. Align gaskets and fasten with retained bolts. Torque to 37 ft-lb. (50 Nm).
4. Install harness connections to water temperature sender and sensor.
5. Install reservoir hose to crossover. Tighten all hose clamps securely.
6. Install thermostat and thermostat retainer.
7. Carefully install heat exchanger to crossover.

IMPORTANT: Do not overtighten heat exchanger retaining strap. The 2 holding slots will weaken under excessive pressure.

8. Install heat exchanger retaining strap. Tighten securely.
9. Refill closed cooling system.

⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without cooling water being supplied to seawater pickup pump.

10. Start engine and check for leaks.

Changing Coolant

NOTICE

For information and procedures on draining the Seawater Section of Closed Cooling (Coolant) Models refer to SECTION 1B. For cold weather or extended storage, refer to SECTION 1B.

IMPORTANT: Closed cooling section must be kept filled year–round with recommended coolant.

Coolant Recommendations

⚠ CAUTION

Propylene glycol, alcohol or Methanol based antifreeze or plain water are not recommended for use in fresh water section of cooling system at any time.

NOTE: *All factory installed closed cooling systems come filled with Extended Life 5/100 Coolant. This antifreeze requires draining and replacing every five years or 1000 hour of operation, whichever comes first. The color of this antifreeze is orange. For best results any "top-off" fluid used should be Extended Life 5/100 Coolant. If Extended Life 5/100 Coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require replacement of the coolant every two years or 400 hours of operation, whichever comes first.*

In areas where the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Draining Instructions

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then remove cap.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

IMPORTANT: Closed cooling section must be kept filled year round with recommended coolant. If engine will be exposed to freezing temperatures, make sure closed cooling section is filled with Extended Life 5/100 Coolant or an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

IMPORTANT: Observe precautions previously outlined before proceeding.

1. Remove pressure cap from coolant reservoir.
2. Remove both hex head drain plugs located approximately 6 inches (152 mm) behind the engine mounts.
3. Drain coolant into a suitable container.
4. After coolant has drained completely, reinstall drain plugs. Tighten securely.
5. Clean closed cooling system.
6. Fill closed cooling system.

Cleaning Closed Cooling System

Closed cooling section of closed cooling system should be cleaned at least once every five years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Always follow manufacturer's instructions for the cleaner.

If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hookup and flushing procedure.

NOTICE

For information and procedures for draining and flushing Seawater Section of Closed Cooling (Coolant) Models, refer to SECTION 1B. For cold weather or extended storage, refer to SECTION 1B.

Filling Closed Cooling System

⚠ CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in coolant section of Closed Cooling System at any time.

It is recommended that the coolant section of Closed Cooling System be filled with a 50/50 mixture of Extended Life 5/100 Coolant and pure, soft water. This coolant MUST BE used regardless of whether freezing temperatures are expected to provide adequate corrosion protection. In areas where Extended Life 5/100 Coolant is not available and the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer's recommendations).

NOTE: *Coolant section capacity is approximately 19 U.S. Quarts (18 l).*

1. Remove pressure cap from coolant reservoir.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

⚠ CAUTION

Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.

IMPORTANT: This closed cooling system flows coolant at a high rate. Higher idle speeds increase dispersion of trapped air into system making it more difficult to purge trapped air. Operate at idle during filling and air purging when specified.

2. Fill reservoir to the FULL mark with recommended coolant solution.
3. Replace pressure cap.
4. With engine running, check hose connections, fittings and gaskets for leaks. Also observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and determine cause.

⚠ WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

5. Recheck coolant level after first boat test and add coolant, if necessary.
6. Maintain coolant level in reservoir at or near the FULL mark with engine at normal operating temperature.

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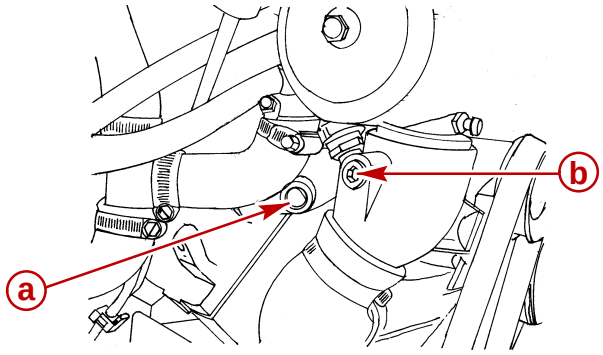
Auxiliary Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met:

- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8 in. (16 mm) I.D. (inside diameter).**
- **Make heater connections ONLY at locations described in the following instructions.**
- **Check complete system for leaks after heater is connected into cooling system.**
- **Check for overheating condition (of engine) after heater is connected.**

⚠ CAUTION

The heater must be mounted lower than the top of the heat exchanger. If the heater is higher than the heat exchanger and some coolant is lost from system, an air pocket may form in the closed cooling system. This can cause the engine to overheat.



77013

a - Supply Hose Connection
b - Return Hose Connection

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EXHAUST SYSTEM

Section 7A - Manifolds, Elbows And Risers

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7 A

Torque Specifications

Description	lb-in.	lb-ft	Nm
Hose Clamp		Securely	
Exhaust Elbow Studs-to-Manifold		15	20
Exhaust Manifold-to-Cylinder Head		26	35
Exhaust Elbow Nuts		12	16
Water Rail Nuts		6	8
Water Rail Studs		7	10
Water Rail Cap Screws		7	10

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
Quicksilver Loctite 510 Sealant	92-804874
Quicksilver Loctite 271 Sealant	92-809820
Quicksilver Loctite 242 Sealant	Obtain Locally

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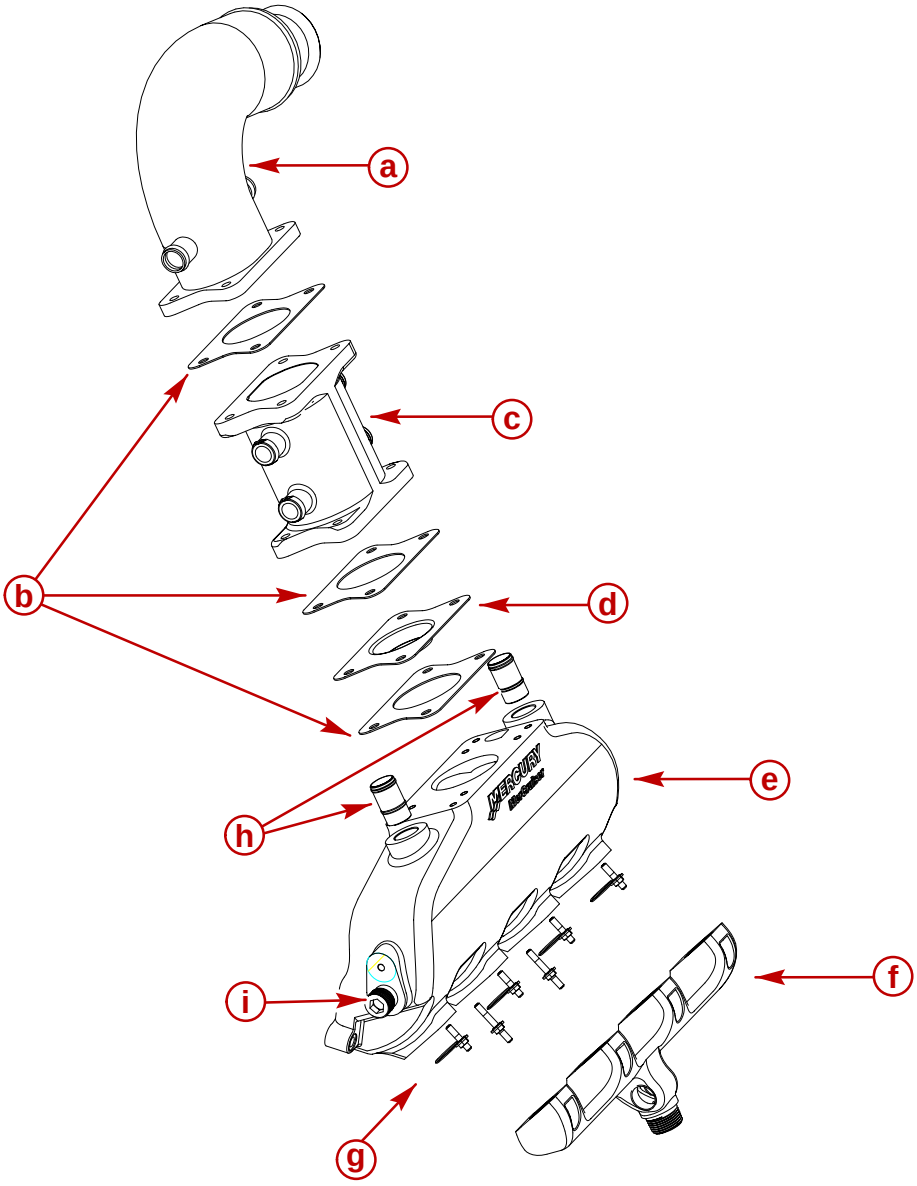
Exploded View



a - Exhaust Elbow
b - Gaskets
c - Riser
d - Turbulator
e - Manifold
f - Water Rail
g - Fasteners
h - Fittings
i - Pipe Plug

Removal

⚠ WARNING

Avoid possible injury or damage to equipment should wires be accidentally shorted. Disconnect BOTH battery cables from battery before proceeding.

1. Disconnect battery cables from battery.

⚠ CAUTION

To avoid severe engine damage. Exhaust elbows and manifolds MUST BE drained to prevent water from entering combustion chambers when exhaust elbows are removed.

2. Drain water from manifold, elbow and riser, if equipped.
3. Disconnect exhaust and cooling hoses.
4. Remove any other components that are mounted to the manifold, elbow and riser, if equipped.
5. Remove elbow and riser, if equipped.
6. Remove exhaust manifold fasteners.
7. Remove manifold assembly and discard gaskets.

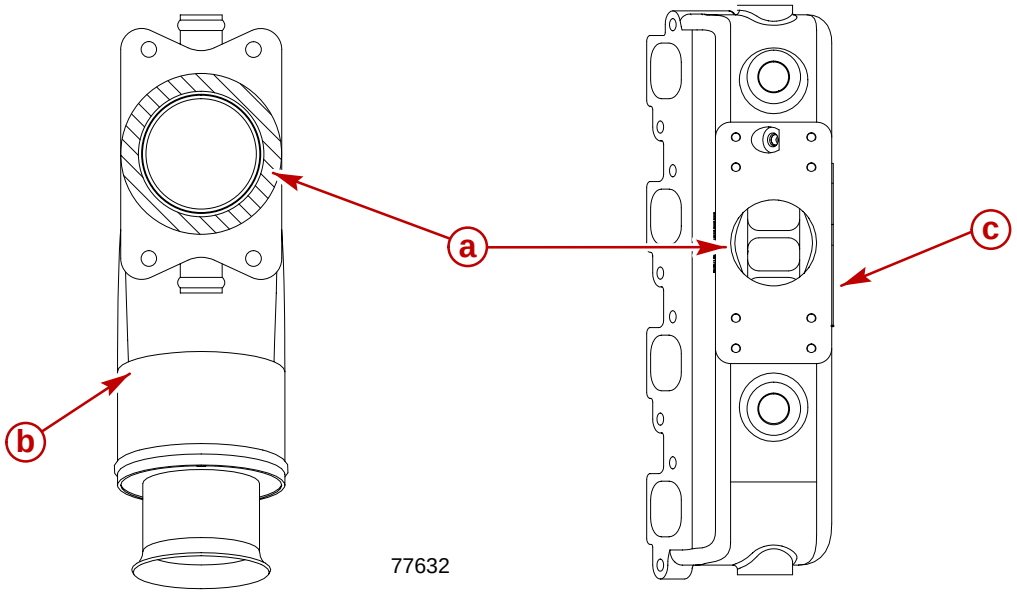
Cleaning and Inspection

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Check water passages for foreign material. Passages must be clean for efficient cooling.
3. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold.

IMPORTANT: If plugs are removed, coat threads with Quicksilver Perfect Seal before reinstalling.

4. Check for cracks.
5. To test manifold and water rail for leaks, block-off plates, plugs or short hoses with plugged ends must be used. One block-off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block-off plates. Apply 20 psi (138 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.

6. Inspect all sealing surfaces carefully. Machined surfaces must be clean and free of all marks and deep scratches or exhaust leaks may result.



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a - Sealing Surfaces
b - Elbow
c - Manifold

7. Check the flatness of all gasket surfaces. Maximum overall warp is .003 in. (0.07 mm), with not more than a .001 in. (0.02 mm) difference within 1 in. (25 mm).

NOTE: *Maximum material that can be removed is .010 in. (0.25 mm) to flatten a gasket surface.*

8. Look at the condition of the metal around the exhaust outlet in the casting. Inspect for damaged metal caused by salt water or exhaust gas corrosion in the manifold, elbow and riser, if equipped. Replace all damaged parts.

Installation

Manifold

1. Align O-rings onto water rail.
2. Install water rail to exhaust manifold.
   a. If studs and nuts, apply Loctite 271 to manifold side of stud and Loctite 242 to nut side of stud. Torque studs to 7 lb-ft (10 Nm) and nuts to 6 lb-ft (8 Nm).
   b. If cap screws, apply Loctite 271 to threads of cap screws. Torque to 7 lb-ft (10 Nm).
3. Using new gasket, install exhaust manifold to cylinder head.
4. Apply Loctite 271 to the fasteners. Torque fasteners to 26 lb-ft (35 Nm).
5. Apply Loctite 271 to the threads of the elbow studs. Install exhaust elbow studs into manifold. Torque to 15 lb-ft (20 Nm).
6. Using a new gasket, install exhaust elbow and riser to exhaust manifold. Apply Loctite 242 to the threads at the top of the exhaust elbow studs. Torque fasteners to 12 lb-ft (16 Nm).
7. Install any components previously removed.
8. Install exhaust elbows and cooling hoses.
9. Reconnect battery cables to battery. Tighten securely.
10. Start engine and check for fuel, exhaust and water leaks.

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DRIVES

Section 8A - Velvet Drive 5000 Series Transmission

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8 A

Tools

Description	Part Number
Pressure Gauge (0-500 psi)	Obtain Locally

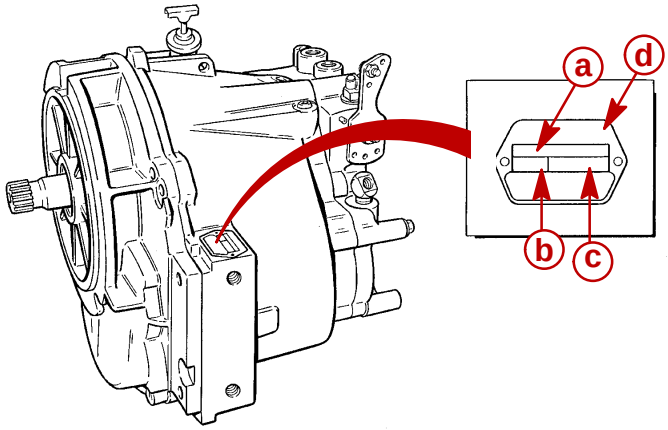
Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Engine Coupler Spline Grease	92-816391A4
Quicksilver 2-4-C Marine Lubricant	92-825407A3
Quicksilver Perfect Seal	92-34227--1

Velvet Drive 5000A Down Angle

Identification

The transmission identification plate is located on the top left side of the transmission. Refer to charts following to determine engine and transmission combinations.



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Transmission Identification Plate

- **a** - Model Number
- **b** - Ratio (A And B Position)
- **c** - Serial Number
- **d** - Identification Plate Model Color Code

Specifications

RATIOS AND PART NUMBERS

Ratio (Nominal)	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.5:1	Black	20-01-003	805495A6
2.1:1		20-01-004	805495A4
2.5:1		20-01-005	805495A5
2.8:1		20-01-006	805495A7

FLUID SPECIFICATIONS

NOTICE
Unit Of Measurement: U.S. Quarts (Liters)
All capacities are approximate fluid measures.

Make and Model	Capacity	Fluid Type
Velvet Drive 5000A Down Angle (All Ratios)	2.75 (2.6) [1]	Dexron III Automatic Transmission Fluid

NOTE: *[1] Use dipstick to determine fluid exact level.*
Warm Fluid Level Check: *The transmission should be at operating temperature [175° F (79° C) maximum] to receive an accurate oil level reading.*
Cold Fluid Level Check: *To ease checking fluid level, the dipstick can be marked or scribed. First the procedure for warm fluid level must be performed, then allow boat to sit overnight. Remove and wipe clean the dipstick. Insert clean dipstick and mark the cold fluid level.*

PRESSURE SPECIFICATIONS

Engine RPM	Neutral Gear PSI (kPa)		Forward Gear or Reverse Gear PSI (kPa)	
	Min.	Max.	Min.	Max.
900	10 (69)	50 (344)	250 (1724)	400 (2757)
2400	50 (344)	70 (483)		

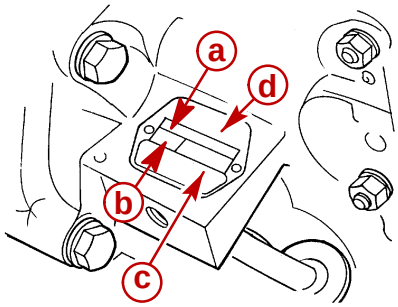
TORQUE SPECIFICATIONS

Description	lb-in.	lb-ft	Nm
Drain Plug		25	34
Fluid Hose-to-Cooler			
Fluid Hose-to-Housing			
Rear Mounts-to-Transmission		45	61
Shift Lever-to-Valve	114		13
Transmission-to-Flywheel Housing		45	61
Neutral Start Safety Switch	120		14
Propeller Shaft Coupler-to-Output Flange		50	68

Velvet Drive 5000V V-Drive

Identification

The transmission identification plate is located on the top left side of the transmission. Refer to charts following to determine engine and transmission combinations.



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Transmission Identification Plate

- **a** - Model Number
- **b** - Ratio (A And B Position)
- **c** - Serial Number
- **d** - Identification Plate Model Color Code

Specifications

RATIOS AND PART NUMBERS

Ratio (Nominal)	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.5:1	Blue	20-02-003	807481A5
2.1:1		20-02-004	807481A6
2.5:1		20-02-005	807481A7

FLUID CAPACITIES

NOTICE
Unit Of Measurement: U.S. Quarts (Liters)
All capacities are approximate fluid measures.

Make and Model	Capacity	Fluid Type
Velvet Drive 5000V	3.5 (3.3) [1]	Dexron III Automatic Transmission Fluid

NOTE: *[1] Use dipstick to determine exact fluid level.*
Warm Fluid Level Check: *The transmission should be at operating temperature [175°F(79° C)] maximum to receive an accurate oil level reading.*
Cold Fluid Level Check: *To ease checking fluid level, the dipstick can be marked or scribed. First the procedure for warm fluid level must be performed, then allow boat to sit overnight. Remove and wipe clean the dipstick. Insert clean dipstick and mark the cold fluid level.*

PRESSURE SPECIFICATIONS

Engine RPM	Neutral Gear PSI (kPa)		Forward Gear or Reverse Gear PSI (kPa)	
	Min.	Max.	Min.	Max.
900	10 (69)	50 (344)	250 (1724)	400 (2757)
2400	50 (344)	70 (483)		

TORQUE SPECIFICATIONS

Description	lb-in	lb-ft	Nm
Drain Plug (Bushing)		25	34
Fluid Hose to Bushing		25	34
Pump Housing to Adapter		20	27
Rear Mounts to Transmission		45	61
Shift Lever to Valve		10	14
Transmission to Flywheel Housing		50	68
Neutral Start Switch		10	14

Velvet Drive 5000 Series

Engine

All current production engines are LH rotation. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

Installed angle of MIE inboard transmission and engine should not exceed a maximum of 18° of the water line.

Transmission

Transmission gear ratio is marked on transmission identification plate, which is located on the port (left) side of transmission. Transmission output shaft rotation and propeller rotation required is indicated on a decal on transmission case. Transmission rotation is described when viewed from the rear of transmission with transmission in forward gear selector position.

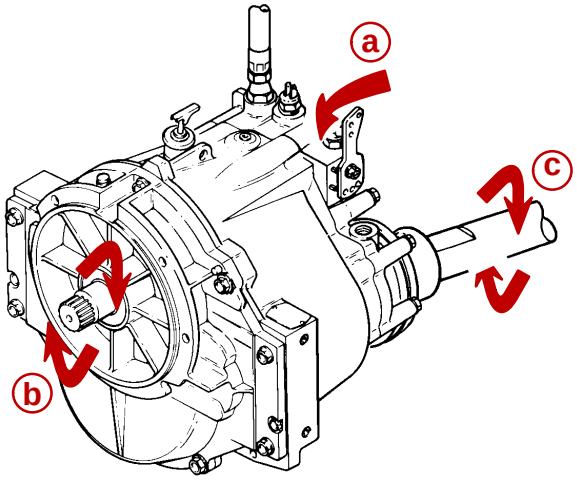
- DO NOT start or crank engine without fluid in transmission.
- Use only recommended fluid in transmission.
- Except in an emergency, never shift transmission at engine speeds above 1000 rpm.
- Free wheeling of one propeller (in a twin engine boat), at trolling speeds, will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Be sure proper fluid level exists before free wheeling propeller.
- DO NOT paint shift lever poppet ball and spring. Paint will prevent proper action of the detent.
- Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.
- Always use specified oil cooler, hoses and fittings.

Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow end). The term left-hand (LH) refers to rotation in the counterclockwise (CCW) direction. The term right-hand (RH) refers to rotation in the clockwise (CW) direction. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise. Propeller rotation is not necessarily the same as engine rotation.

Transmission / Propeller Rotation

These transmissions are full power reversing transmissions, allowing a standard LH rotation engine to be used for both propeller rotations. Propeller rotation (output shaft rotation) is determined by shift cable attachment at the remote control. Be sure to use correct rotation propeller and shift cable hook up for direction desired.



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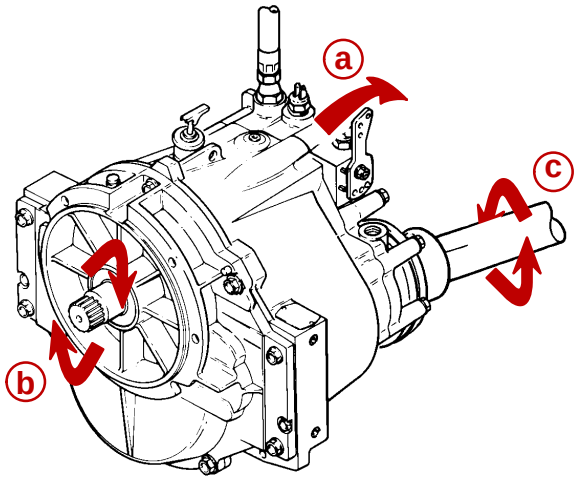
Typical

a - Direction Of Shift Lever Engagement (Position A Toward Flywheel)
b - Engine/Transmission Input Shaft Shaft Rotation Direction (LH)
c - Transmission Output/Propeller Shaft Rotation Direction (LH)



71888

Typical

a - Direction Of Shift Lever Engagement (Position B Away From Flywheel)
b - Engine/Transmission Input Shaft Rotation Direction (LH)
c - Transmission Output/Propeller Shaft Rotation Direction (RH)

Transmission Fluid Level

TRANSMISSION WARM

The transmission should be at operating temperature (190° maximum) to get an accurate oil level reading. Oil will expand when heated. Oil will drain back from the cooler. Expansion and drain-back can significantly affect oil level.

IMPORTANT: Oil level must be checked immediately after engine shut-down to prevent an incorrect reading. Oil drains back into the transmission from the cooler and cooler lines.

1. When the transmission is at operating temperature, place selector lever in NEUTRAL.
2. Shut off engine.
3. Remove dipstick and wipe clean.

IMPORTANT: Do not screw dipstick in; press it firmly in and remove.

4. Immediately insert clean dipstick and read oil level.
5. Add or remove oil as necessary until the oil is at the required mark.

TRANSMISSION COLD

NOTE: *For ease of checking the oil prior to engine start-up, a cold oil level mark can be made. To find the cold oil level mark, the oil level must first be set according to the warm oil level checking procedure.*

1. Let the boat sit overnight. Insert clean dipstick and read level.
2. Put a mark on the dipstick at the cold oil level.

NOTE: *You can use the new mark to check the oil level when cold. If oil level adjustment is needed, add oil to the new mark.*

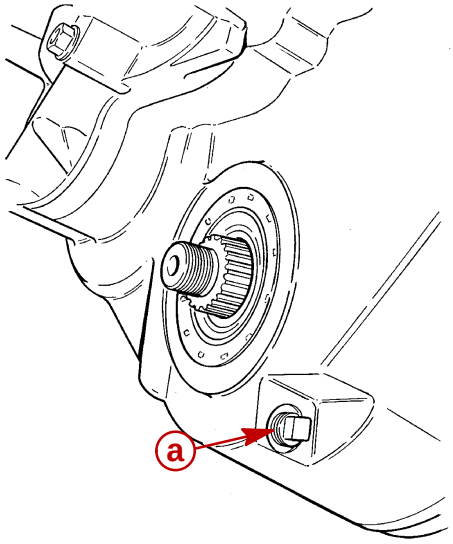
FILLING

If transmission fluid level is low, use specified transmission fluid to fill.

1. Remove dipstick.
2. Fill transmission with fluid, through dipstick hole, to bring fluid up to full mark.
3. Reinstall dipstick. Be sure to tighten T-handle securely. DO NOT overtighten.
4. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

CHANGING

1. Clean area around drain plug shown.
2. Remove dipstick
3. Remove drain plug. Drain oil from transmission into a suitable container.



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a - Drain Plug

4. Check oil for the following foreign matter:

- **Metal Particles -** A few small particles are normal. Larger metal chips are an early sign of transmission failure which indicates the transmission should be disassembled and inspected for internal damage.
- **Rubber Particles -** Indication of cooler hose wear. Hoses should be inspected for cracks or fraying. Replace damaged hoses.

5. Coat drain plug threads with Quicksilver Perfect Seal. Install and torque drain plug to specification.
6. Refill transmission with specified fluid.

Removal

NOTICE
The following procedure describes removal of transmission without removing engine. If engine must be removed, refer to SECTION 2.

1. Disconnect negative battery cable.
2. If required, drain transmission fluid
3. Disconnect cooler water hoses.

NOTE: *Fluid cooler should be removed with transmission.*

4. Disconnect shift cable from transmission.
5. Disconnect wires from neutral start safety switch.
6. Disconnect wires from transmission fluid temperature switch.
7. Loosen trunnion clamping fasteners on engine mounts (port and starboard).
8. Remove coupling nuts and bolts and separate propeller shaft flange from transmission output flange.
9. Remove the four rear engine mount-to-engine bed fasteners and hardware.
10. Support rear part of engine using a suitable hoist or wooden blocks under flywheel housing.
11. Support transmission with a hoist or by other suitable means through the lifting eye on the transmission case.
12. Remove port and starboard rear mount brackets (with base and trunnion) from transmission.

⚠ CAUTION
Avoid damage to transmission input shaft or engine coupler. Make sure transmission is completely supported before removing hardware attaching transmission to flywheel housing.

13. Remove all hardware attaching transmission to flywheel housing.
14. Move transmission straight back and away from engine to completely disengage splines on input shaft.
15. Carefully lift out transmission.

Installation

1. Check transmission output shaft rolling torque.
1. Apply Quicksilver Engine Coupler Spline Grease to transmission input shaft splines and engine drive plate splines.
2. Using a suitable hoist, position transmission in boat and align transmission splines with drive plate splines.
3. Slide transmission into place and secure with attaching hardware. Torque transmission to flywheel housing fasteners to specification. Remove hoist.
4. Install rear mount brackets to transmission. Torque fasteners and hardware to specification.
5. Using hoist, raise engine and transmission to remove blocks (if employed). Lower assembly to engine bed. Securely tighten the four rear engine mount-to-engine bed fasteners with hardware. Relieve hoist tension.
6. Connect wires to neutral start safety switch.
7. Connect wires to transmission fluid temperature switch.

⚠ CAUTION

Improper shift cable connection and adjustment can cause premature clutch failure.

8. Connect and adjust shift cables. Refer to Shift Cable Adjustment.
9. Refer to SECTION 2C and check engine final alignment.
10. After final engine and coupler alignment has been properly set (with boat in the water), connect propeller shaft coupler-to-transmission output flange with bolts, lockwashers and nuts. Torque to 50 lb-ft (68 Nm).

IMPORTANT: Be certain to torque trunnion clamping fasteners on engine mounts (port and starboard) which were loosened during removal.

IMPORTANT: All coupler bolts must be SAE Grade 8 (Metric Grade 10.9) or better, with a shoulder (grip length) long enough to pass through the face mating plane of couplers.

11. Install transmission fluid cooler and hoses. Torque hose fittings at cooler and transmission housing to specification.
12. Refill transmission with specified fluid.
13. Connect negative battery cable. Tighten clamp securely.
14. Check for leaks and check fluid level after first engine start-up.

Shift Control And Cables

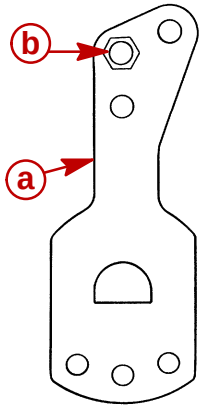
⚠ CAUTION

Shift control and shift cable must position transmission shift lever exactly as stated in this manual, or transmission, as a result of improper shift lever positioning, will not be covered by Velvet Drive Warranty.

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed in any manner, or repositioned, or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

TRANSMISSION SHIFT LEVER AND SHIFT CABLE BRACKET

1. The shift lever has three holes as illustrated following. The shift cable anchor stud is installed in the middle hole when using Quicksilver Remote Control cables.



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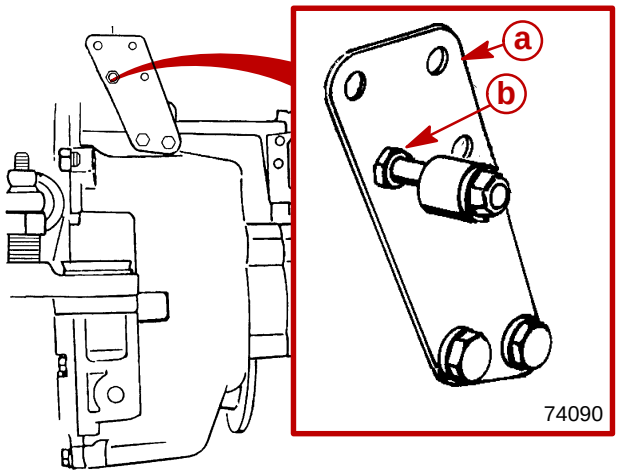
a - Shift Lever
b - Shift Cable Anchor Stud Location (For Quicksilver Shift Cables)

⚠ WARNING

Avoid serious personal injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole when using bracket with four anchor location holes.

2. The shift cable bracket has four holes as illustrated following. The shift cable anchor stud is installed in the in the lower, front hole when using Quicksilver Remote Control cables.

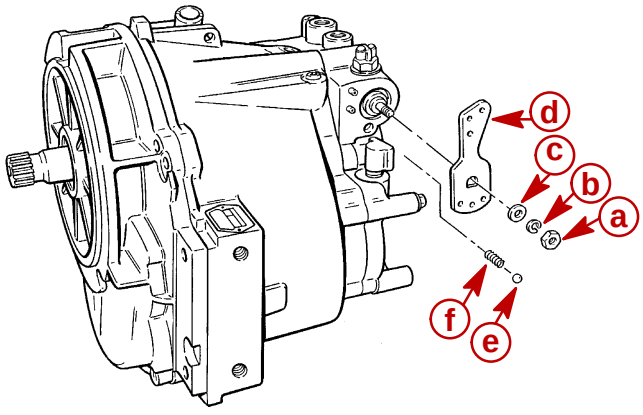


a - Shift Cable Bracket
b - Shift Cable Anchor Stud Location

SHIFT LEVER INSTALLATION

Shift lever and related parts must be assembled as shown.

1. Lubricate poppet ball, spring and holes in shift lever with Quicksilver 2-4-C Marine Lubricant.
2. Install poppet spring and ball. Retain ball by placing shift lever on shaft.
3. Install flat washer, lockwasher and nut on shaft.
4. Torque nut to specification.



a - Nut
b - Lockwasher
c - Flat Washer
d - Shift Lever
e - Poppet Ball
f - Poppet Spring

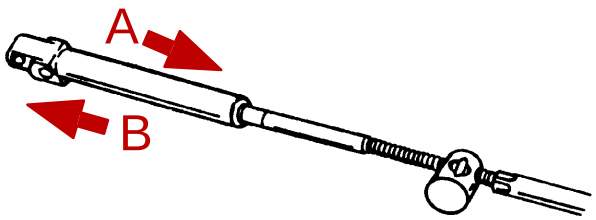
5. After installation, move shift lever through FORWARD, NEUTRAL and REVERSE positions. No more than finger-tip effort should be required. If valve binds, cause for binding must be found and corrected.

INDEX

SHIFT CABLE ADJUSTMENT

For Left-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction "A" when remote control handle is placed in forward position.

For Right-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction "B" when remote control handle is placed in forward position.



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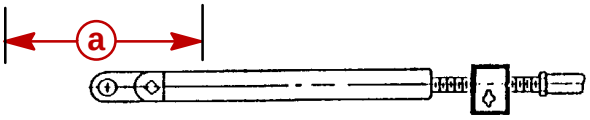
Remote control must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.



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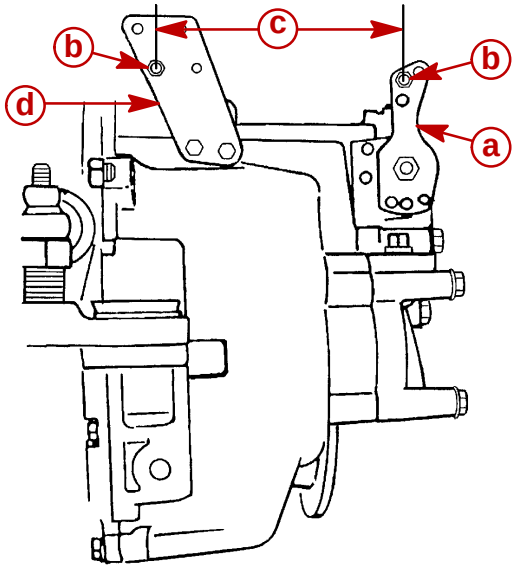
a - Total Minimum Shift Cable Travel - 2-3/4 in. (70 mm)

IMPORTANT: The distance between anchor studs (Dimension "c") shown in the following illustration, is set at 7-1/8 in. (181 mm).



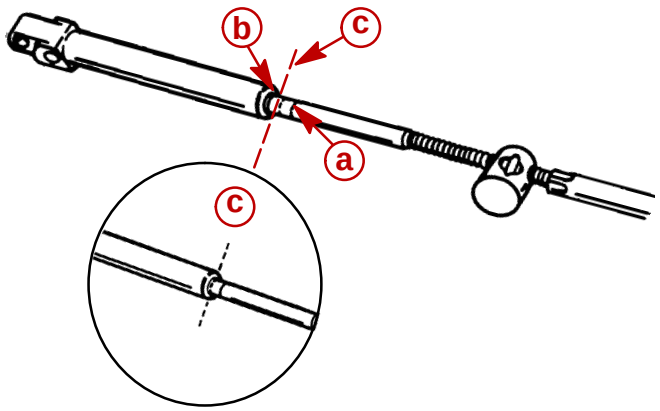
73284

a - Shift Lever
b - Anchor Stud
c - Dimension Between Anchor Studs - 7-1/8 in. (181 mm)
d - Shift Cable Bracket

INDEX

IMPORTANT: When installing shift cables, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to shift cables.

1. Place remote control shift lever and transmission shift lever in neutral position.
2. Remove nuts and washers from shift cable attaching studs.
3. Locate center of remote control and control shift cable play (backlash) as follows:
   a. Check that remote control is in neutral position.
   b. Push in on control cable end with enough pressure to remove play; mark position "**a**" on tube.
   c. Pull out on control cable end with enough effort to remove play; mark position "**b**" on tube.
   d. Measure distance between marks "**a**" and "**b**;" mark position "**c**" half-way between marks "**a**" and "**b**."



72603

4. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide, with attaching points on transmission.
5. Temporarily install shift cable. Do not secure at this time.

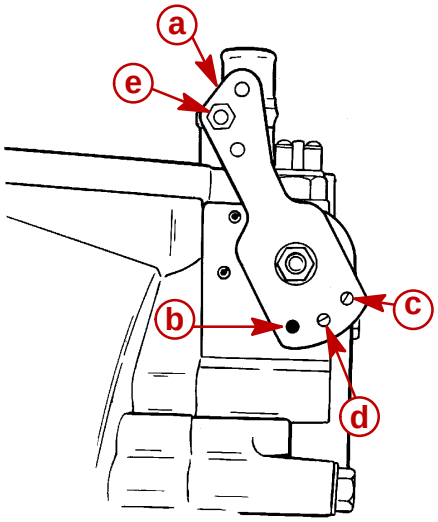
IMPORTANT: Transmission is "fully" in gear when shift lever comes to a stop, in either direction.

6. Place remote control shift lever in gear and check position of transmission shift lever. Shift lever must be positioned as shown.

⚠ CAUTION

Remote control and shift cable must position transmission shift lever exactly as shown, or transmission failure may occur. Do not remove poppet ball or spring.

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if remote control and shift cable do not position shift lever exactly as shown.

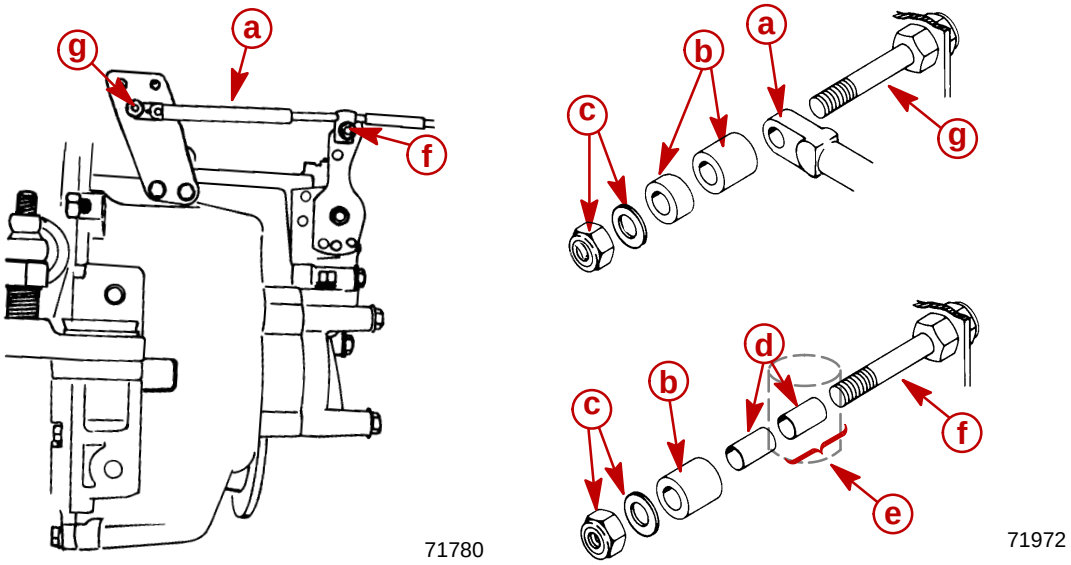


73248

a - Transmission Shift Lever
b - Poppet Ball Must Be Centered In This Detent Hole When Left-hand Propeller Shaft Rotation Is Desired
c - Poppet Ball Must Be Centered In This Detent Hole When Right-hand Propeller Shaft Rotation Is Desired
d - Poppet Ball Must Be Centered In This Detent Hole For Neutral Position
e - Install Shift Lever Stud In This Hole When Using Quicksilver Shift Cables

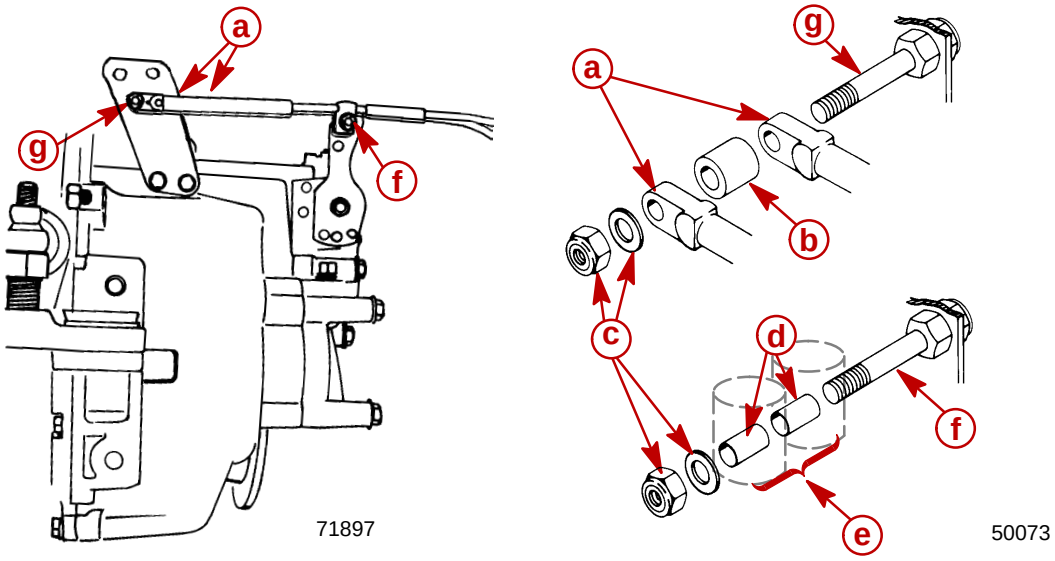
7. Place remote control shift lever in opposite gear and again check transmission shift lever position. Lever must be positioned as shown by "**c**."
8. If transmission shift lever will not position properly in one gear or both gears, recheck shift cable adjustment and travel as previously instructed. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be repaired or replaced.
9. Install nut and washer to cable end guide stud. Tighten until contacts, then loosen 1 full turn.

10. Install nut and washer to cable barrel stud. Tighten until they contact. Tighten securely, but DO NOT overtighten.



Typical Single Cable Installation - Rear Approach

- **a** - Cable End Guide
- **b** - Spacer (As Required)
- **c** - Elastic Stop Nut And Washer
- **d** - Bushings
- **e** - Cable Barrel [Position Only Indicated In Right Drawing]
- **f** - Cable Barrel Stud
- **g** - Cable End Guide Stud



Typical Dual Cable Installation - Rear Approach

- **a** - Cable End Guide
- **b** - Spacer (As Required)
- **c** - Elastic Stop Nut And Washer
- **d** - Bushings
- **e** - Cable Barrels [Positions Only Indicated In Right Drawing]
- **f** - Cable Barrel Stud
- **g** - Cable End Guide Stud

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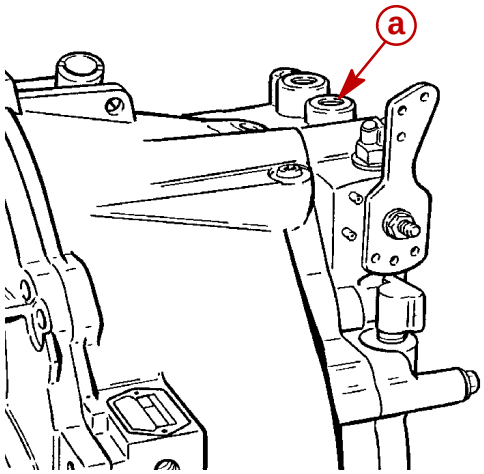
Pressure Test

1. Remove transmission temperature switch.
2. Install a suitable pressure gauge.



73247

a - Main Line Pressure Tap

3. With boat in water, start engine and operate until normal operating temperature is reached.
4. Refer to Specifications for pressure readings.

Transmission Repair

Mercury Marine does not stock or sell replacement parts for the down angle transmission. Velvet Drive has a network of distributors throughout the world to service their product. These distributors have a dealer network to service the transmissions. Service manuals for each transmission can be obtained from Velvet Drive.

For the location of your closest distributor or for service literature contact:

Velvet Drive Transmissions
Division of Regal Beloit
200 Theodore Rice Boulevard
Industrial Park
New Bedford, MA 02745
Phone: (508) 979-4800

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DRIVES

Section 8B - ZF/Hurth Transmissions

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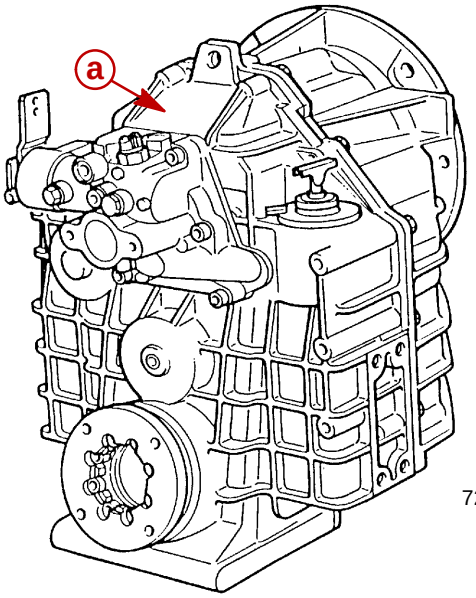
8 B

Identification

The transmission identification plate is located on the top rear of the transmission. Refer to charts following to determine engine and transmission combinations.



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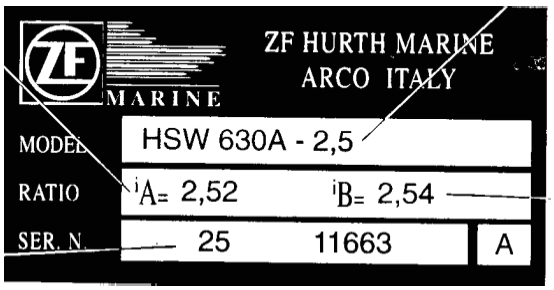

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Typical Hurth Transmission Identification Plate

a - Serial Number And Gear Ratio

Specifications

RATIOS AND PART NUMBERS

Model	Ratio (Normal)[1]	Hurth Model Number	Mercury Marine Part Number
630A	1.5:1	HSW630A	18900A1
	2.1:1		18901A1
	2.5:1		18902A1
	2.7:1		862220A1
630V	1.55:1	HSW630V	814437A1
	2.0:1		814438A1
	2.5:1		814439A1
800A2	2.85:1	HSW800A2	806730A1

[1]Ratio may be rounded off in some cases.

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Fluid Specifications

NOTICE
Unit Of Measurement: U.S. Quarts (Liters) **All capacities are approximate fluid measures.**

Make and Model	Capacity	Fluid Type
ZF (Hurth)		Dexron III Automatic Transmission Fluid
630V	4-1/4 (4.0)	
630A	3-1/4 (3.0)	
800A	5-3/4 (5.5)	

NOTE: *[1] Use dipstick to determine fluid exact level.*
Warm Fluid Level Check: *The transmission should be at operating temperature [190° F (90° C) maximum] to receive an accurate oil level reading.*
Cold Fluid Level Check: *To ease checking fluid level, the dipstick can be marked or scribed. First the procedure for warm fluid level must be performed, then allow boat to sit overnight. Remove and wipe clean the dipstick. Insert clean dipstick and mark the cold fluid level.*

Operating Specifications

Description	Specification
Shifting Pressure	312-341 psi (21.5-23.5 bar)
Operating Temperature	130°-175°F (54°-79°C)

Torque Specifications

Description	lb-in.	lb-ft	Nm
Transmission Housing Halves Bolts and Nuts		36	49
Control Block-To-Housing		18	25
Output Flange		14	18
Mounts		45	61
Transmission To Flywheel Housing			

Tools

Description	Part Number
Thermometer [(3/8-NPT, Thread 0-270°F (-18 to -132°C)]	Obtain Locally
Pressure Gauge (0-500 psi), (1/8-NPT)	

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Engine Coupler Spline Grease	92-816391A4
Quicksilver Liquid Neoprene	92-25711--3
Loctite Type A	Obtain Locally
Loctite 515	

Important Information

Engine

All current production engines are left hand rotation. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

Installed angle of MIE inboard transmission and engine should not exceed a maximum of 18° of the water line.

Transmission

Transmission gear ratio is marked on transmission identification plate, which is located on the top of transmission. Transmission rotation is described when viewed from the rear of transmission.

- DO NOT start or crank engine without fluid in transmission.
- Use only recommended fluid in transmission.
- Except in an emergency, never shift transmission at engine speeds above 1000 rpm.
- Free wheeling of one propeller (in a twin engine boat) at trolling speeds will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Be sure proper fluid level exists before free wheeling propeller.
- Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.
- Always use specified oil cooler, hoses and fittings.

Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow end). The term left-hand (LH) refers to rotation in the counterclockwise (CCW) direction. The term right-hand (RH) refers to rotation in the clockwise (CW) direction. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise.

Transmission / Propeller Rotation

The ZF/Hurth transmissions are full power reversing transmissions, allowing a standard LH rotation engine to be used for both propeller rotations. Propeller rotation is determined by shift cable attachment at the remote control. Be sure to use correct rotation propeller and shift cable hook up for direction desired.

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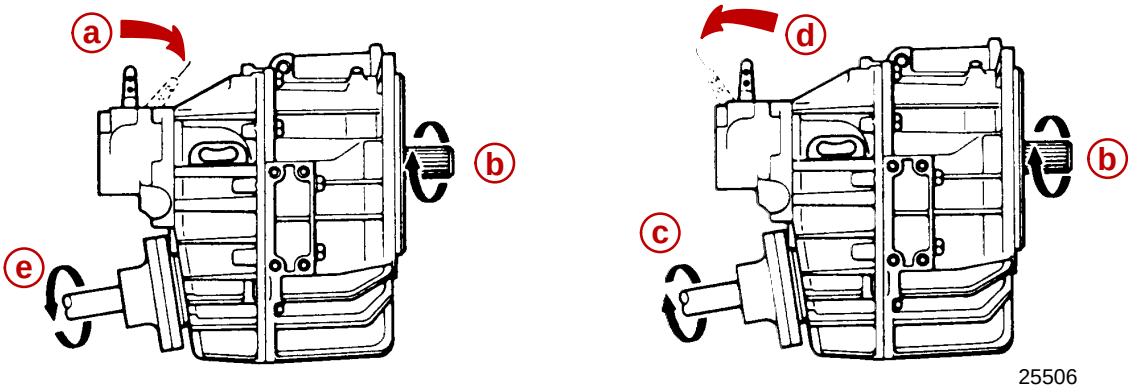

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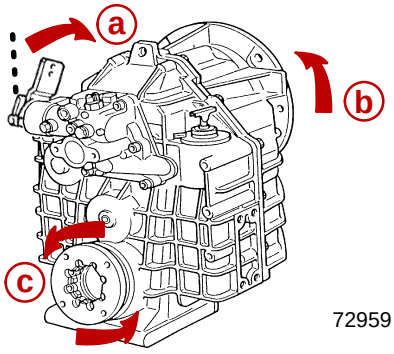
Hurth 630A or 800A - 8° Down-Angle Transmissions



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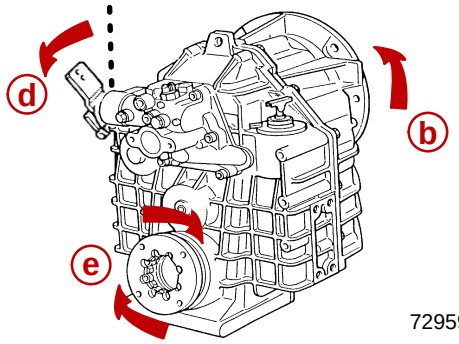


72959

Hurth 630V - V-Drive Transmissions

- **a** - Direction Of Shift Lever Engagement (Toward Flywheel)
- **b** - Engine/Transmission Input Shaft Rotation Direction (LH)
- **c** - Transmission Output/Propeller Shaft Rotation Direction (LH)
- **d** - Direction Of Shift Lever Engagement (Away From Flywheel)
- **e** - Transmission Output/Propeller Shaft Rotation Direction (RH)
- **f** - Transmission Output/Propeller Shaft Rotation Direction (LH As Viewed At Propeller)
- **g** - Transmission Output/Propeller Shaft Rotation Direction (RH As Viewed At The Propeller)

Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid.

IMPORTANT: The fluid level dipstick is located on the port side of transmission.

Checking

TRANSMISSION WARM

The transmission should be at operating temperature (190° maximum) to get an accurate oil level reading. Oil will expand when heated. Oil will drain back from the cooler. Expansion and drain-back can significantly affect oil level.

IMPORTANT: Oil level must be checked immediately after engine shut-down to prevent an incorrect reading. Oil drains back into the transmission from the cooler and cooler lines.

1. When the transmission is at operating temperature, place selector lever in NEUTRAL.
2. Shut off engine.
3. Remove dipstick and wipe clean.

IMPORTANT: Do not screw dipstick in; press it firmly in and remove.

4. Immediately insert clean dipstick and read oil level.
5. Add or remove oil as necessary until the oil is at the required mark.

TRANSMISSION COLD

NOTE: *For ease of checking the oil prior to engine start-up, a cold oil level mark can be made. To find the cold oil level mark, the oil level must first be set according to the warm oil level checking procedure.*

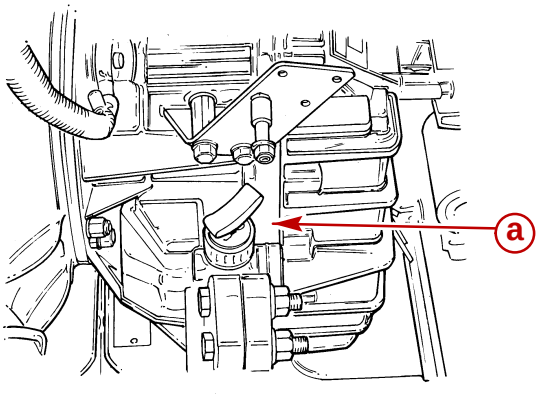
1. Let the boat sit overnight. Insert clean dipstick and read level.
2. Put a mark on the dipstick at the cold oil level.

NOTE: *You can use the new mark to check the oil level when cold. If oil level adjustment is needed, add oil to the new mark.*

Filling

If transmission fluid level is low, use specified transmission fluid to fill.

1. Remove dipstick.
2. Fill transmission through dipstick tube.
3. Replace dipstick and recheck level.



77564

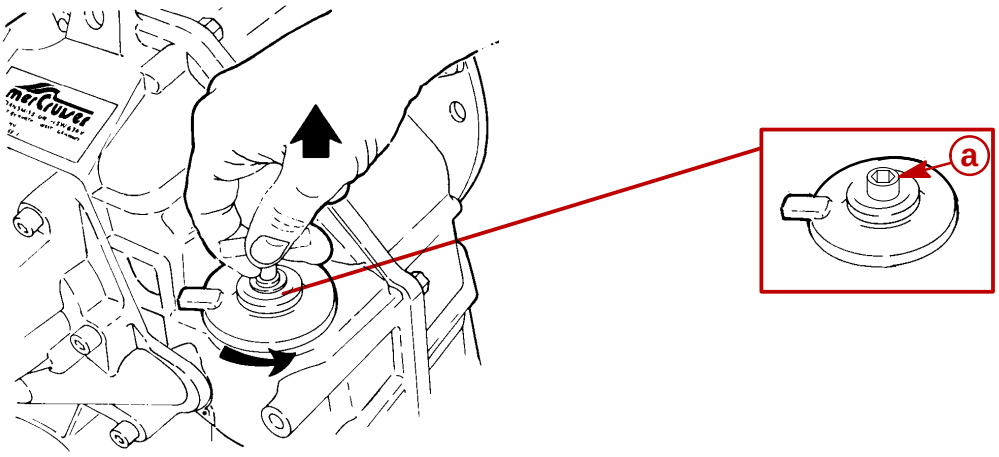
a - Dipstick Tube

Changing

1. Clean the exterior of transmission before disassembly.

NOTE: *Later model Hurth transmissions will be equipped with an allen head socket screw on the oil filter cover.*

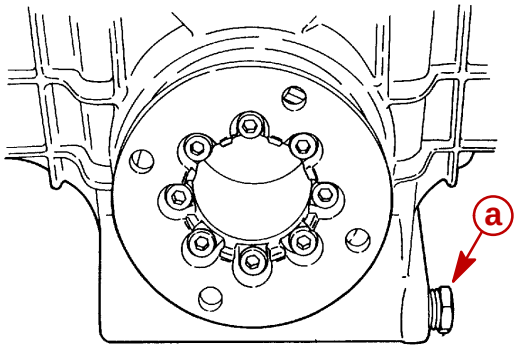
2. Remove oil filter from housing by turning (counterclockwise) and pulling at the same time.



27666

a - Set Screw (Later Models)

3. 630V Only: Remove drain plug from transmission and allow fluid to drain. Reinstall drain plug and tighten securely.



73013

a - Drain Plug (630V Only)

4. 630A Only: Suction fluid out through filter tube.

Transmission Removal

1. Disconnect negative battery cable.
2. If required, drain transmission fluid
3. Disconnect water cooler hoses.

NOTE: *Fluid cooler should be removed with transmission.*

4. Disconnect shift cable from transmission.
5. Disconnect wires from neutral start safety switch.
6. Disconnect wires from transmission fluid temperature switch.
7. Loosen trunnion clamping fasteners on engine mounts (port and starboard).
8. Remove coupling nuts and bolts and separate propeller shaft flange from transmission output flange.
9. Remove the four rear engine mount-to-engine bed fasteners and hardware.
10. Support rear part of engine using a suitable hoist or wooden blocks under flywheel housing.
11. Support transmission with a hoist or by other suitable means through the lifting eye on the transmission case.
12. Remove port and starboard rear mount brackets (with base and trunnion) from transmission.

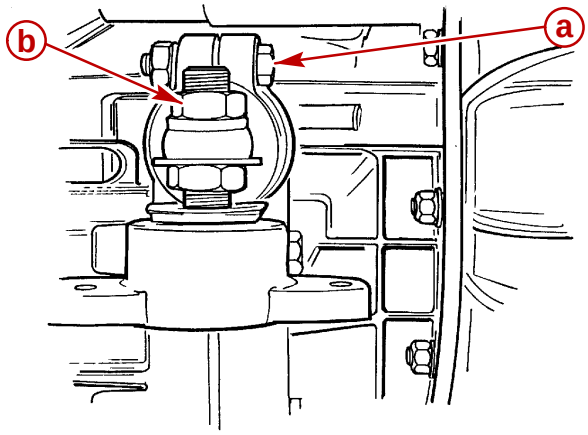
⚠ CAUTION

Avoid damage to transmission input shaft or engine coupler. Make sure transmission is completely supported before removing hardware attaching transmission to flywheel housing.

13. Remove all hardware attaching transmission to flywheel housing.
14. Move transmission straight back and away from engine to completely disengage splines on input shaft.
15. Carefully lift out transmission.
16. Remove bolts and locknuts and remove transmission.

Transmission Installation

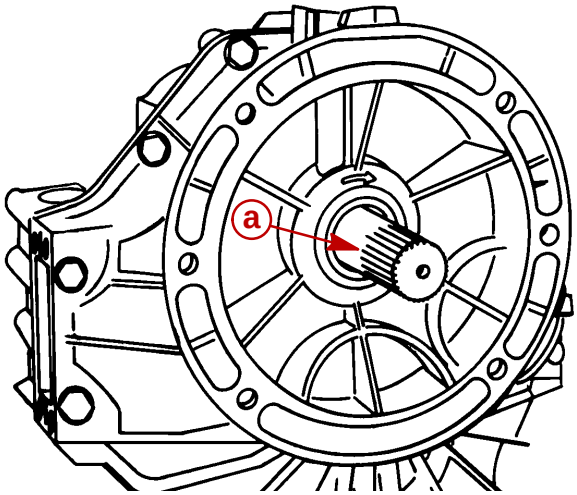
1. Check transmission output shaft rolling torque.



72720

a - Bolts (4), 2 On Each Side
b - Locknuts (2), 1 On Each Side

1. Apply Quicksilver Engine Coupler Spline Grease to transmission input shaft splines and engine drive plate splines.



71044

a - Input Shaft

2. Using a suitable hoist, position transmission in boat and align transmission splines with drive plate splines.
3. Slide transmission into place and secure with attaching hardware. Torque transmission to flywheel housing fasteners to 45 lb-ft (61 Nm). Remove hoist.
4. Install rear mount brackets to transmission. Torque fasteners and hardware to 45 lb-ft (61 Nm).

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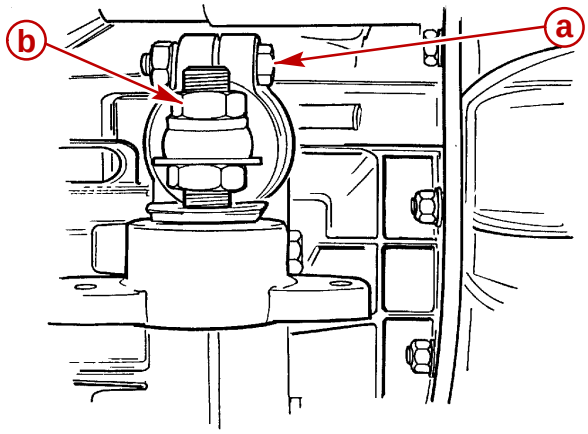
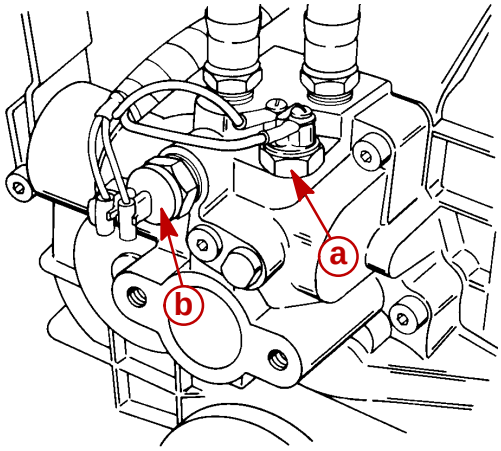
5. Using hoist, raise engine and transmission to remove blocks (if employed). Lower assembly to engine bed. Securely tighten the four rear engine mount-to-engine bed fasteners with hardware. Relieve hoist tension.



72720

a - Bolts (4), 2 On Each Side
b - Locknuts (2), 1 On Each Side

6. Connect seawater hoses to transmission fluid cooler and tighten hose clamps securely.
7. Connect wires to neutral safety switch and to audio warning temperature switch. Coat connections on neutral safety switch with Quicksilver Liquid Neoprene.
8. Connect wires to neutral start safety switch.
9. Connect wires to transmission fluid temperature switch.



50686

a - Neutral Safety Switch
b - Audio Warning Temperature Switch

⚠ CAUTION

Improper shift cable connection and adjustment can cause premature clutch failure.

10. Connect and adjust shift cables. Refer to Shift Cable Adjustment.
11. Refer to SECTION 2B and check engine final alignment.

12. After final engine and coupler alignment has been properly set (with boat in the water), connect propeller shaft coupler-to-transmission output flange with bolts, lockwashers and nuts. Torque to 50 lb-ft (68 Nm).

IMPORTANT: Be certain to torque trunnion clamping fasteners on engine mounts (port and starboard) which were loosened during removal.

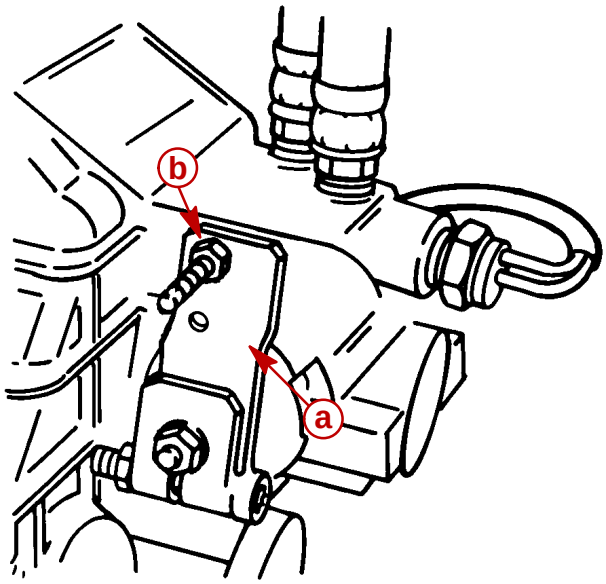
IMPORTANT: All coupler bolts must be SAE Grade 8 (Metric Grade 10.9) or better, with a shoulder (grip length) long enough to pass through the face mating plane of couplers.

13. Install transmission fluid cooler and hoses. Torque hose fittings at cooler and transmission housing to 25 lb-ft (34 Nm).
14. Refill transmission with specified fluid.
15. Connect negative battery cable. Tighten clamp securely.
16. Check for leaks and check fluid level after first engine start-up.

Shift Control And Cables

Transmission Shift Lever and Shift Cable Bracket

1. The shift lever has two holes as illustrated following. The shift cable anchor stud is installed in the top hole when using Quicksilver Remote Control cables.



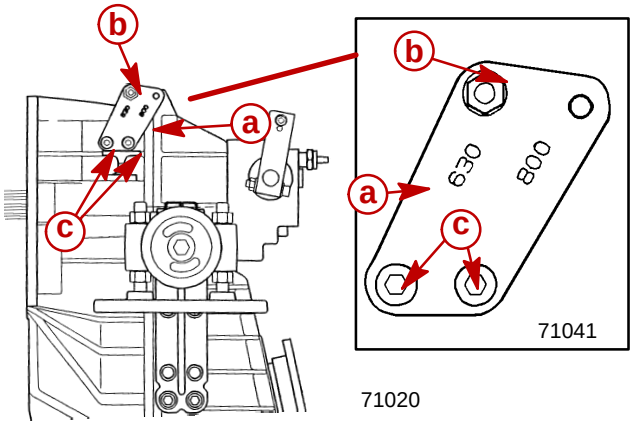
77520

a - Shift Lever
b - Shift Cable Anchor Stud Location (For Quicksilver Shift Cables)

2. **On bracket with two anchor location holes:** Be certain anchor stud is installed in the hole marked “630.”

⚠ WARNING

Avoid serious personal injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole when using bracket with two anchor location holes.



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Shift Cable Bracket - Anchor Stud Position Shown for 630 Transmission

a - Shift Cable Bracket
b - Shift Cable Anchor Stud
c - Bracket To Transmission Fasteners

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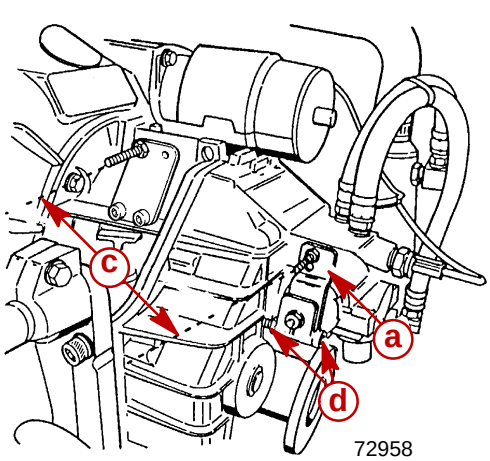
Shift Cable Installation and Adjustment

IMPORTANT: Ensure that shift lever is positioned approximately 10° aft of vertical as shown when in the neutral detent position. Also, ensure that the distance between studs in the following is set at 7-1/8 in. (181 mm). If necessary, loosen clamping bolt and position lever so that dimension "c" is as shown when in the neutral detent position, and retighten clamping bolt.



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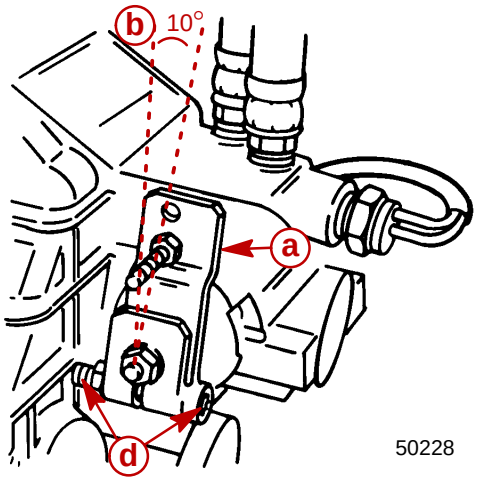


50228

Typical Hurth Transmission Shown

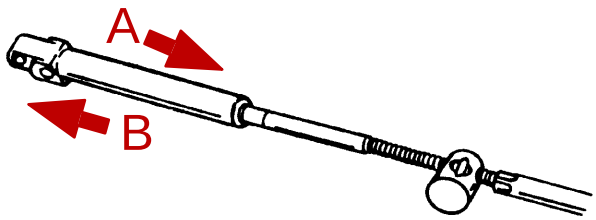
- **a** - Shift Lever
- **b** - Shift Lever In Neutral Detent
- **c** - Dimension Between Studs - 7-1/8 In. (181 mm)
- **d** - Clamping Bolt

⚠ CAUTION

Avoid severe transmission damage. All ZF/Hurth Transmissions require Standard Left-Hand rotation engines. NEVER connect a ZF/Hurth Transmission to a Right-Hand rotation engine.

IMPORTANT: Transmission propeller rotation is determined by the shift cable installation in the remote control.

- **RIGHT-HAND PROPELLER ROTATION** - Control cable will have to be installed in remote control so that cable end will move in direction "**A**" when shift handle is placed in the forward position.
- **LEFT-HAND PROPELLER ROTATION** - Control cable will have to be installed in remote control so that cable end will move in direction "**B**" when shift handle is placed in the forward position.



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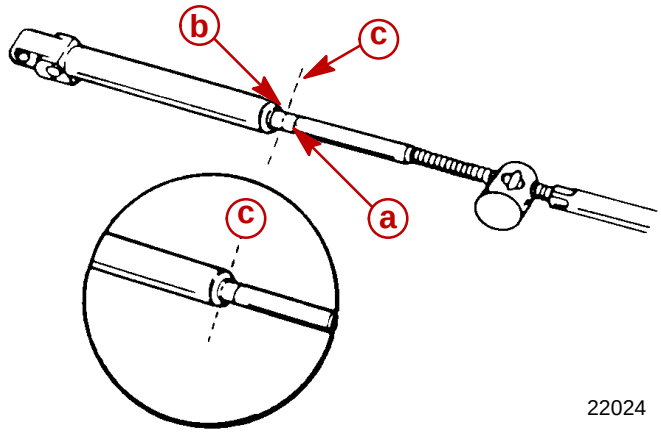
3. Place remote control shift lever and transmission shift lever in neutral position.
4. Remove nuts and washers from shift cable attaching studs.
5. Locate center of remote control and control shift cable play (backlash), as follows:
   a. Check that remote control is in neutral position.
   b. Push in on control cable end with enough pressure to remove play and mark position “a” on tube.
   c. Pull out on control cable end with enough effort to remove play and mark position “b” on tube.
   d. Measure distance between marks “a” and “b,” and mark position “c,” halfway between marks “a” and “b.”



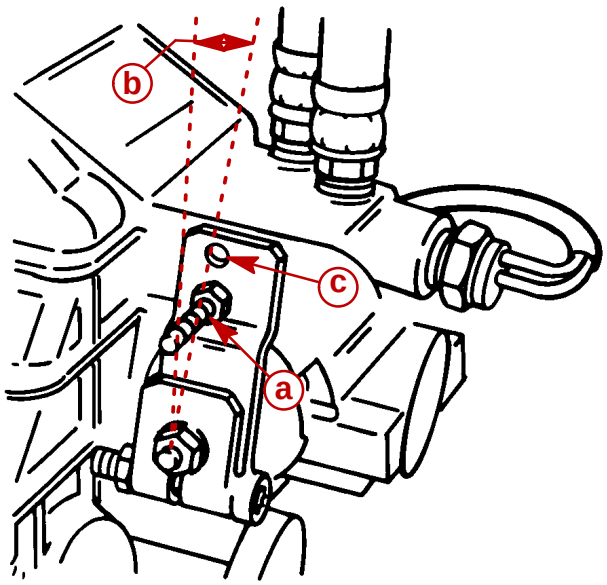
22024

6. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide with attaching points on transmission.
7. Temporarily install shift cable. Do not secure at this time.

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop, in either direction.

8. Place remote control shift lever in forward gear position. Ensure transmission is fully in gear, as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.
9. Place remote control shift lever in reverse gear position. Again ensure transmission is fully in gear as follows:
   a. Hold shift lever in position.
   b. Carefully slide shift cable off of anchor points.
   c. Attempt to move shift lever further.

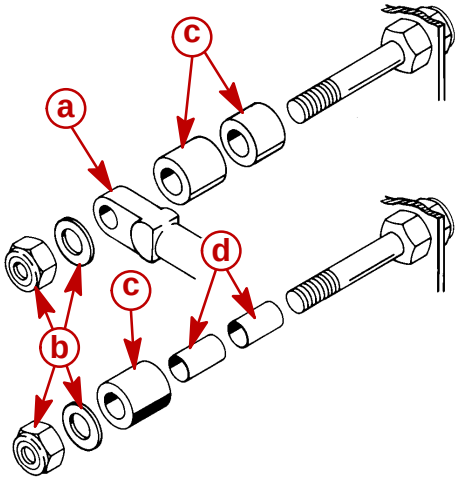
10. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in both gears, move transmission shift lever stud from top hole in shift lever to bottom hole and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



50228

a - Shift Lever Stud (In Bottom Hole, If Required)
b - Lever, In Neutral Detent, Must Be Approximately 10 Degrees Of Vertical
c - Shift Lever Top Hole

11. Install nut and washer to cable end guide stud. Tighten until contacts, then loosen one full turn.
12. Install nut and washer to cable barrel stud. Tighten until they contact. Then loosen 1/2 turn.



50229

a - Cable End Guide
b - Locknut and Washer
c - Spacer
d - Bushings
e - Cable Barrel

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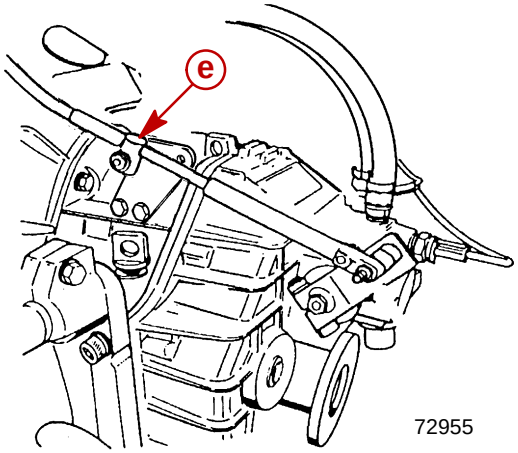
13. Once shift cable adjustment is correct, secure shift cable(s) with hardware as shown, referring to appropriate configuration following:

NOTE: *To change cable approach direction on single or dual station installations, only the spacer/bushings have to be switched to the opposite stud. The studs are identical.*

IMPORTANT: Tighten locknut until it contacts and then loosen 1/2 turn.



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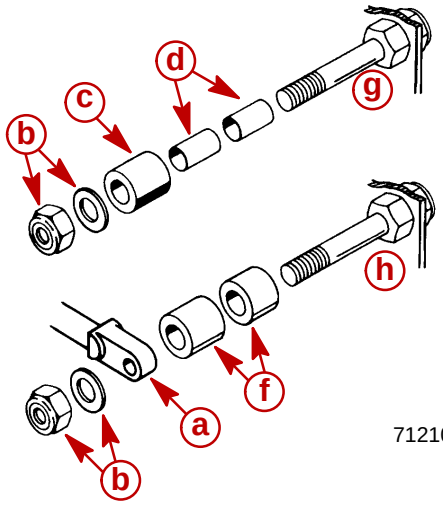
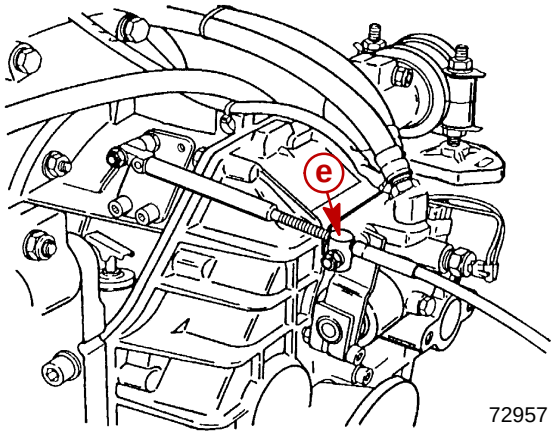


71210

Typical Single Cable - Forward Approach

- **a** - Cable End Guide
- **b** - Locknut and Washer
- **c** - Spacer (Fits Over Bushings)
- **d** - Bushing
- **e** - Cable Barrel
- **f** - Spacers (Fits Over Stud)
- **g** - Cable Barrel Stud
- **h** - Cable End Guide Stud



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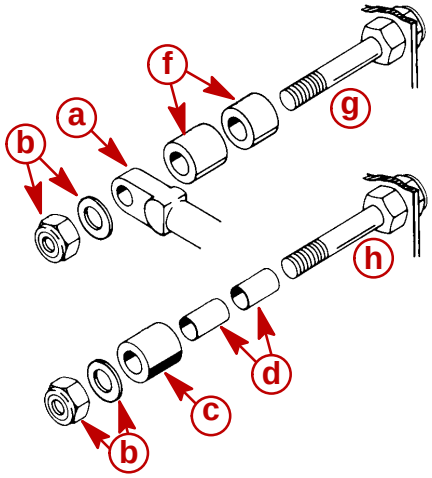

50229

Typical Single Cable - Rear Approach

- **a** - Cable End Guide
- **b** - Locknut And Washer
- **c** - Spacer (Fits Over Bushings)
- **d** - Bushing
- **e** - Cable Barrel
- **f** - Cable Barrel Stud
- **g** - Cable End Guide Stud

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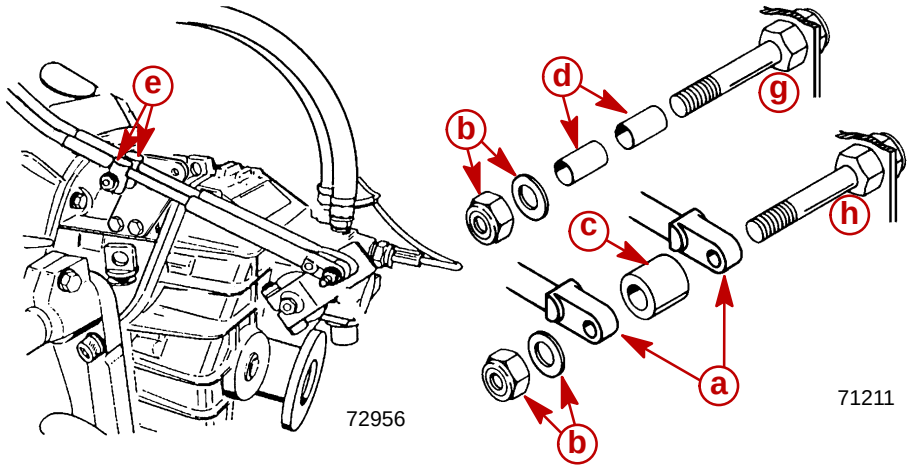
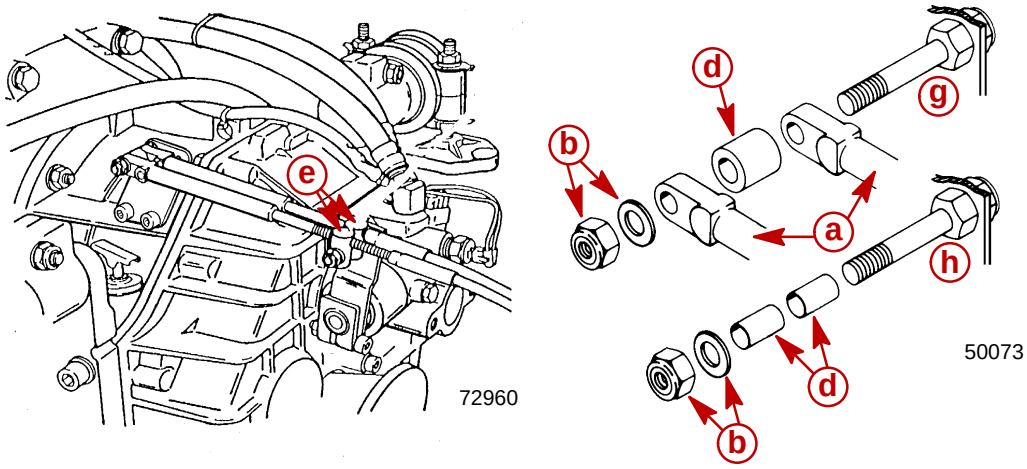


Typical Dual Cable - Forward Approach

- **a** - Cable End Guide
- **a** - Cable End Guide
- **b** - Locknut And Washer
- **c** - Spacer (Fits Over Bushings)
- **d** - Bushing
- **e** - Cable Barrel
- **f** - Spacers (Fits Over Stud)
- **g** - Cable Barrel Stud
- **h** - Cable End Guide Stud



Typical Dual Cable - Rear Approach

- **a** - Cable End Guide
- **b** - Locknut And Washer
- **c** - Spacer (Fits Over Bushings)
- **d** - Bushing
- **e** - Cable Barrel
- **f** - Spacers (Fits Over Stud)
- **g** - Cable Barrel Stud
- **h** - Cable End Guide Stud

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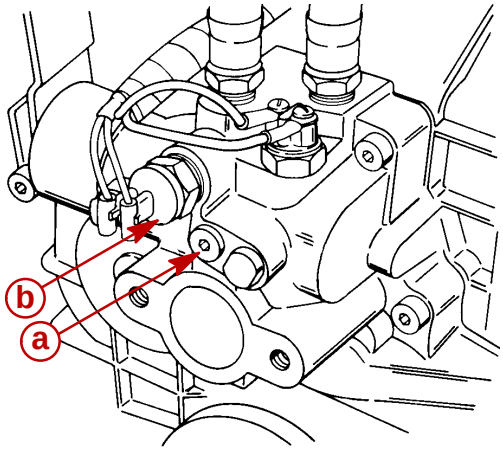
Functional Tests

1. Connect a pressure gauge and thermometer to fluid pump at locations shown.



50686

a - Pressure Gauge (m10x1 Thread - Remove Plug)
b - Thermometer (3/8 In. Thread) - Remove Temperature Sender

2. Ensure fluid temperature and shifting pressure meet specification.
3. Check for leaks.

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POWER STEERING

Section 9A - Pump

Table of Contents

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9 A

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Torque Specifications

Description	lb-in.	lb-ft	Nm
Pump Mounting Bracket-To-Engine		30	41
Power Steering Hose Fittings		23	31

Tools

Description	Part Number
Pulley Installer	91-93656A1
Pulley Removal Tool	Obtain Locally

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
Transmission Fluid Dexron III or Equivalent	Obtain Locally

Precautions

⚠ WARNING

Always disconnect battery cables from battery before working on engine to prevent fire or explosion.

⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠ CAUTION

Do not pry on power steering pump or alternator when adjusting belt tension. Serious damage may result.

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Serpentine Drive Belt

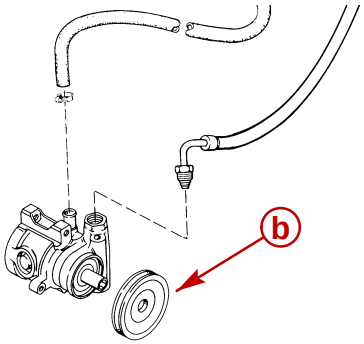
Refer to **SECTION 1B.**

Power Steering Pump Pulley Replacement

NOTE: *Serpentine belt pulley removal and installation requires a special puller tool. See your local automotive repair dealer for appropriate tool.*

Removal

1. Install appropriate puller on end of pulley and shaft as shown.
2. While holding tool with suitable wrench, turn threaded screw until pulley is removed.



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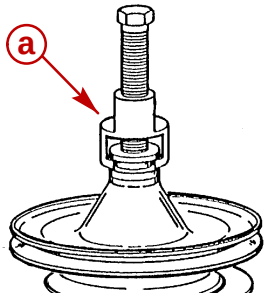

72821

Typical Removal Tool Shown

a - Puller Tool
b - Serpentine Pulley

Installation

1. Place pulley on pump shaft.
2. Thread stud into pump shaft. Place bearing over stud.
3. Thread nut onto shaft. Thread tool shaft (and nut) all the way onto stud (threaded into pump shaft).

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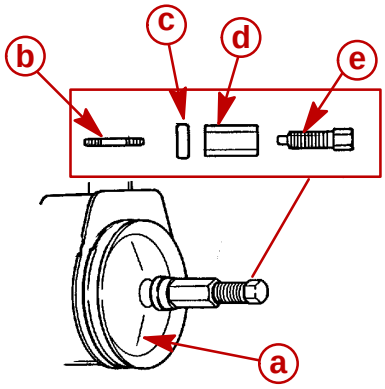
4. Turn nut until face of pulley is even with edge of shaft.



75751

Typical Installation Tool Shown

a - Power Steering Pump Pulley
b - Stud
c - Bearing
d - Nut
e - Tool Shaft

Power Steering Pump

IMPORTANT: Power Steering Pumps are considered non-repairable units and are intended to be replaced with new units.

Removal

1. Remove serpentine belt.
2. Remove 3 bolts fastening power steering pump to engine. Retain bolts.
3. Slide fluid reservoir out of the fastening bracket.
4. Drain fluid from pump and reservoir into appropriate container.

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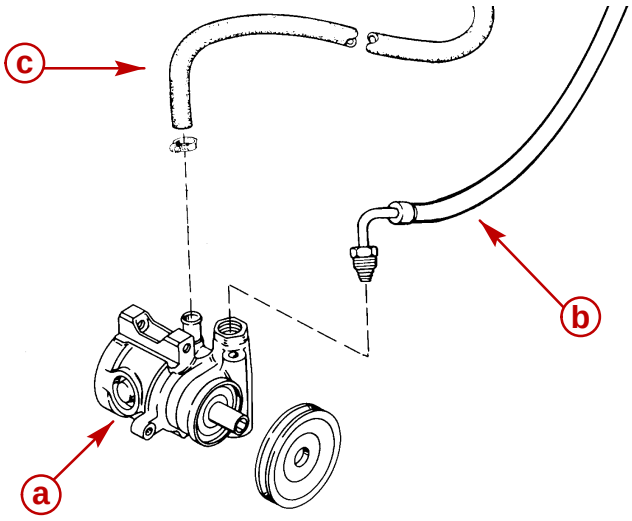
5. Remove high pressure and low pressure hoses from power steering pump.



71035

a - Power Steering Pump
b - High Pressure Hose
c - Low Pressure Hose

6. Drain fluid from hoses into suitable container.
7. Remove power steering pump from bracket.

Inspection

1. Inspect pulley for warp and excessive wear.
2. Inspect hose fittings and the O-ring on the high pressure hose.
3. Inspect bracket for warp, cracks and excessive wear.
4. Inspect reservoir and cap for cracks, excessive wear and signs of leaking.

Installation

1. Remove plug and reconnect hoses to power steering pump.
2. Install pump to engine, using the 3 bolts retained in removal.
3. Reinstall serpentine belt.

Filling and Air Bleeding System

Refer to SECTION 1B.

Checking Pump Fluid Level

Refer to SECTION 1B.

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Hydraulic Hoses

Replace high or low pressure hoses following:

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leaking.

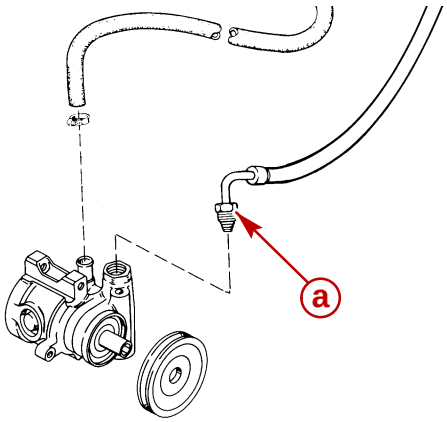
IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

High Pressure Hose (Pump-to-Control Valve)

REMOVAL

NOTE: *Catch fluid that drains from pump and hoses in a suitable container.*

1. Remove high pressure hose fitting with O-ring seal from pump.



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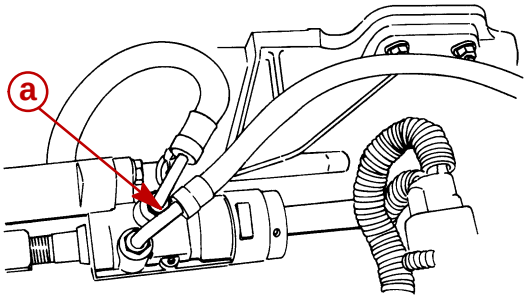
a - High Pressure Hose Fitting

2. Remove hose where routed and secured.
3. Remove fitting from control valve at transom. Remove hose.



73860

a - Power Steering Hose Fitting

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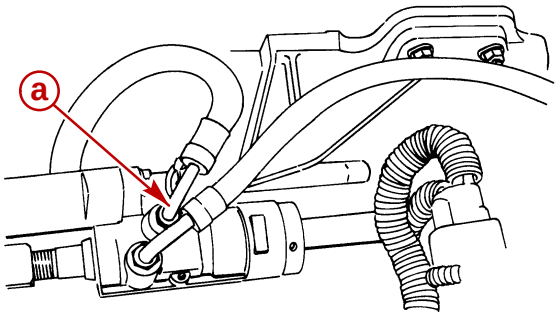
INSTALLATION

⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

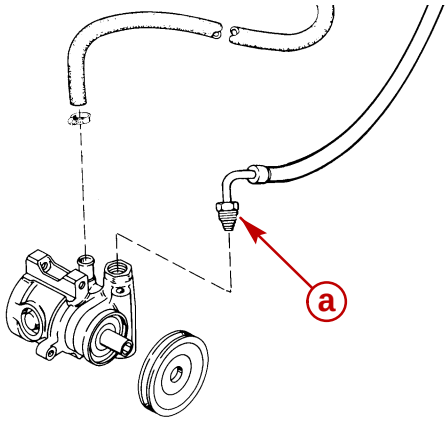
1. Route hose in the same position as prior to removal. Install fitting and torque to 23 lb-ft. (31 Nm). DO NOT cross-thread or overtighten.



73860

a - Power Steering Hose Fitting

2. Be certain a new high pressure hose O-ring is present, and install threaded hose fitting into pump assembly fitting. Tighten hose fitting securely. DO NOT cross-thread or over-tighten.



71035

a - High Pressure Hose Fitting

3. Fill and air bleed system. Refer to SECTION 1B.

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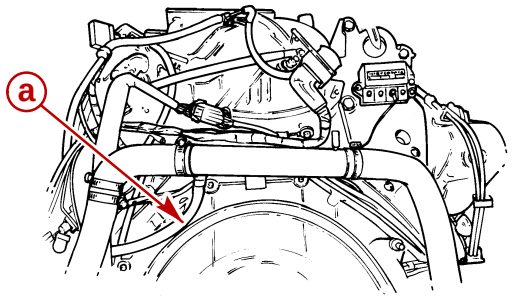
Low Pressure Hose (Cooler-To-Pump)

REMOVAL

NOTE: *Catch fluid that drains from hose, cooler and pump in a suitable container.*

1. Loosen hose clamp and remove hose from fluid cooler.



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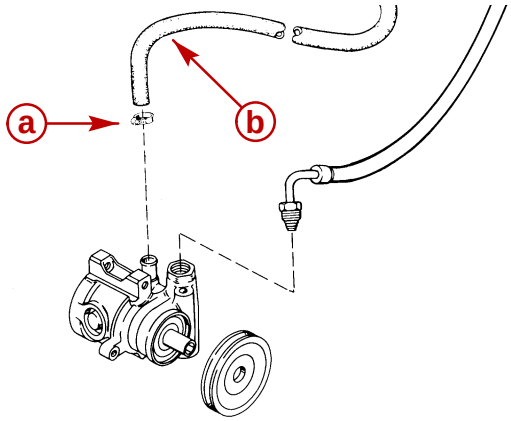
a - Low Pressure Hose

2. Loosen hose clamp and remove hose from back of pump.



71035

a - Hose Clamp
b - Hose

INSTALLATION

1. Using hose clamp, install new low pressure hose on the back of the pump. Tighten clamp securely.
2. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.
3. Fill and air bleed system. Refer to SECTION 1B.

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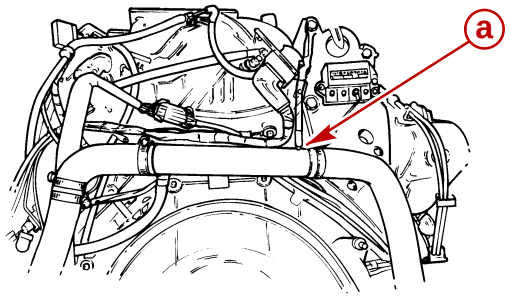
Low Pressure Hose (Control Valve-to-Cooler)

REMOVAL

NOTE: *Catch fluid that drains from hose, cooler and pump in a suitable container.*

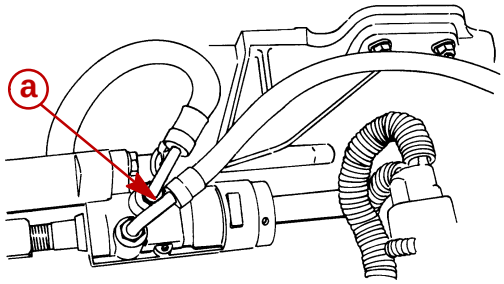
1. Loosen hose clamp and remove hose from fluid cooler.



76942

a - Low Pressure Hose

2. Remove fitting from control valve at transom. Remove hose.



73860

a - Power Steering Hose Fitting

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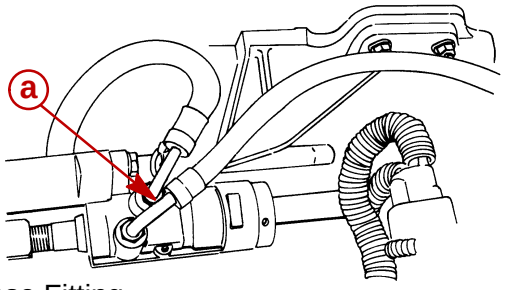
INSTALLATION

⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

1. Route hose in the same position as before removal. Install fitting and torque to 23 lb-ft. (31 Nm). DO NOT cross-thread or overtighten.



73860

a - Power Steering Hose Fitting

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

2. Route hose along flywheel housing and secure with J-clamps provided.
3. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.
4. Fill and air bleed system. Refer to SECTION 1B.

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